

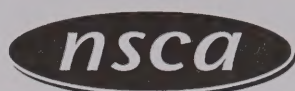
# *clean air* *and environmental protection*

*Spring 2001*

the quarterly journal of the National Society for Clean Air and Environmental Protection vol.31 no.1

- *Air Quality in 2000*
- *Clean Air – are we moving in the right direction?*
- *Particle Characterisation*
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*The National Society for Clean Air and Environmental Protection produces information, organises conferences and training events, and campaigns on air pollution, noise and environmental protection issues. Founded in 1899, the Society's work on smoke control led to the Clean Air Acts. More recently NSCA has been influential in developing thinking on integrated pollution control, noise legislation, and air quality management.*

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# Editorial

## WELCOME TO THE NEW CLEAN AIR

It seems that you can't move at the moment without someone, or something, having a major make-over or a fancy new look. Clean Air is no exception. In response to the wishes of its readers, NSCA has re-vamped its publications with the launch this year of a new monthly Briefing. This will cover news, updates, events and Members and Divisional activities, leaving Clean Air to spend more time and space on reports on a quarterly publication schedule. For the first year at least, each issue will be themed around one of the four major policy areas in which NSCA is active, providing in depth analysis of some of the important and upcoming issues.

This issue focuses on air pollution and air quality, with Bernard Fisher, chairman of NSCA's Air Quality Committee, reviewing the main developments over the last 12 months. On the air quality front, most local authorities have completed their Review and Assessment and are either going through the process of declaring AQMAs and writing their Action Plans, or else contemplating the development of local air quality strategies. As the team at the University of the West of England, led by James Longhurst, point out in their article, we now have far more information about air quality than three years ago. The question is, how do we maintain momentum and keep moving in the right direction?

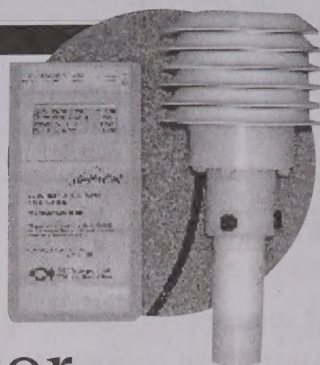
One issue which is unlikely to change in the near future is  $PM_{10}$ , and the team from Advance Environmental put forward a cost effective way for local authorities to address particulate from quarrying. At the other end of the scale is incineration and especially dioxin, both of which are likely to continue their rise up the political agenda in the coming months. The Parliamentary Office for Science and Technology (POST) has once again produced a clear, accessible briefing on a difficult area and it is reproduced here. In addition, Peter Coleman of AEA Technology provides a thorough examination of what dioxins are, where they come from and how to measure them, pointing out that the main source of dioxin exposure is food, followed by soil, with inhalation a long way behind.

Another issue which has been in the public limelight is cleaner fuels, and the role they could play in improving air quality. Claire Holman looks at low sulphur fuels and asks just what are the benefits and where are the costs? Finally for this issue, Tim Williamson looks at some of the issues confronting the power generation industry in its efforts to reduce atmospheric emissions.

The next issue will be focusing on sustainability and environmental management issues, with coverage of the winners of NSCA's Innovations in Sustainable Development Awards. However, there will also be a new "Research Update" section which will cover all areas and be open to submission, so keep those papers coming.

Submissions for Clean Air or the Briefing should be sent to the Commissioning Editor, NSCA, 44 Grand Parade, Brighton, BN2 2QA, or emailed (MS Word format) to [twilliamson@nsca.org.uk](mailto:twilliamson@nsca.org.uk).

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# Reports

## Air Quality Issues at the Beginning of the New Millennium Air Quality in 2000

Bernard Fisher

Chairman, NSCA Air Quality Committee

*This article is a review of air quality issues during the past year, a year in which air quality, indirectly or directly, has frequently been in the news. Activity in connection with air quality has probably been greater than ever before, largely because:*

- *local authorities throughout the country are reaching the end of the first local air quality management review to establish whether air quality objectives will be met;*
- *climate change has been debated as a consequence of the unusually wet weather and consequent floods in the autumn; and*
- *current road transport policy has been debated, following failures of the rail system and the cost and supply of fuel for road vehicles.*

transport plans to contain policies to improve air quality in relation to air quality management areas, and has introduced financial measures or incentives to reduce greenhouse gas emissions. For example from 2001 road vehicle tax will be in four bands related to the carbon dioxide emission and from 2002 company car tax will be related to price and emissions.

With all this interest one might consider that NSCA's work has been completed. However the passing of legislation and the introduction of measures do not automatically mean better air quality, although in many areas improvements can be demonstrated. The air quality management regime has led to much greater pollution monitoring, moderately more understanding of air pollution issues and some greater public awareness, but these on their own do not produce improved health.

### Introduction

Local air quality reviews should have been completed by the end of 2000 and are public documents available from local authorities. NSCA has been very active in providing guidance beyond that issued officially, covering the declaration of air quality management areas (NSCA, 2000a) and on consultation during the process (NSCA, 1999). It has recently produced the first part of guidance (NSCA, 2000b) on how local authorities could develop Local Air Quality Action Plans, following the declaration of Air Quality Management Areas, and local air quality strategies. In considering their options for achieving air quality objectives and implementing potential mitigating measures, such as low car dependency, car-free developments or improved public transport provision, local authorities will need to consider the integrated environmental impact, such as the effect on climate change, energy efficiency and local transport and travel plans.

To a greater or lesser extent all the issues concerning air quality are linked, and they are all related to the wider political and economic policy debate. The recent talks in The Hague were not successful in reaching international agreement on national targets for greenhouse gas emissions. However the UK has a target to reduce carbon dioxide emissions by 20% below 1990 levels by 2010, require local

### The European Perspective

European legislation is an important driver in the implementation of new air pollution control measures. One of the principal aims is to ensure public health and well-being, and to protect the natural environment. This is very difficult to assess at the current levels of most air pollutants, so that regulation relies on the application of the precautionary principle which involves judgement. Over the next few years the current system of managing the most potentially polluting processes (known as IPC - Integrated Pollution Control) is being superseded by a regime based on the European Union Directive on Integrated Pollution Prevention and Control (IPPC). IPPC extends the range of effects that should be considered in the regulation of industrial processes to include broader environmental effects, such as noise, waste and energy efficiency, and to include a wider range of installations, such as landfill sites and large pig and poultry units. IPPC should apply the Best Available Techniques to prevent and reduce emissions, taking into account a balance between costs and environmental benefit, but it still includes an important element of judgement.

The European Union Air Quality Framework Directive sets a framework for a series of Daughter Directives on individual pollutants. The framework is broadly similar to the UK

National Air Quality Strategy with air quality limits set on the basis of protecting human health and the environment, and a system of reporting designed to review air quality objectives and to develop strategies to ensure their achievement. The Daughter Directives set out requirements for the monitoring and assessment of the pollution climate of member states of the European Union. They establish a regime in which modelling data may be used instead of some monitoring sites, when levels of pollutants are below a specified threshold and the size of the exposed population is below specified numbers. The question remains of how representative is a detailed monitoring network, supported by modelling, of the actual exposure of members of the population.

Daughter Directives may extend the range of pollution monitoring and assessment in the UK to pollutants which are not in the UK National Air Quality Strategy. Smaller particles  $PM_{2.5}$  may be included, as well as certain heavy metals (arsenic, cadmium, nickel and mercury). The other group of air pollutants over which there has been increasing concern are the persistent organic pollutants, including PAHs, dioxins, PCBs and pesticides. Volatile organic compounds are also of concern because of their effect on ozone concentrations near the ground. Given that one cannot measure every airborne substance everywhere, there must be dependence in the air quality review on the precautionary principle using risk assessments to decide how to address a potential hazard. However whether to apply a strong or weak degree of precaution is still a matter for judgement.

## Climate Change

Observations suggest that the earth has warmed by about  $0.7^{\circ}\text{C}$  over the last 100 years. The broad body of science is increasingly confident that a substantial part of the global mean warming seen over the last 50 years is human-made and climate models predict that the UK will warm by about  $1.5$  to  $2^{\circ}\text{C}$  over the next 50 years. However at a regional level predictions of climate change are much more uncertain and the uncertainty associated with predictions of average and extreme rainfall over the UK is much larger than for temperature. Climate change will also affect the frequency of local episodes of poor air quality in ways which are uncertain. Relationships between regional climate change and the consequent impacts are unknown and improved knowledge depends on better understanding of complex various interactions. How to mitigate these impacts practically in adaptation measures requires difficult judgements.

## Future Options Appraisal

One of the ways of judging the extent to which individuals or the local community are prepared to help to arrest climate change will arise immediately as a consequence of declaring air quality management areas. The majority of local air quality reviews and assessments have been

completed by now and following the declaration of an AQMA, the local authority will need to produce an Action Plan for reducing the contribution of the primary sources leading to an exceedence. These are typically road traffic or significant Part A or B processes, but may include some area sources. The willingness to choose options affecting an individual's choice to drive, park, shop or walk will be a measure of the community's will to pay a price for environmental improvements. It appears increasingly likely that the declaration of Air Quality Management Areas will be based on exceedences of the long-term average nitrogen dioxide concentration objective. In terms of severe health impacts the influence of  $PM_{10}$  is thought to be greater, but for  $PM_{10}$  the uncertainty in the designation of the Air Quality Management Area is also greater. For both these pollutants the study boundary is much larger than the local authority area so it is difficult to assess the impact of actions.

Air quality has been an area of great activity and will remain so in the New Millennium until it has been clearly demonstrated that the expected benefits of improvement measures have been achieved. Current science has to deal with many unknowns and many of the uncertainties are interlinked. The areas of air quality science where progress is more likely in the short-term, are indoor air and local meteorology. The very challenging areas for science, i.e. the very difficult ones, include health effects, wider environmental impacts and regional climate change. Hence uncertainty has to be built into the decision making, and improvement plans should be decided on the basis of a broad and balanced judgement of the overall environmental impact. There will be a trend towards air quality improvement based on individual choice, regardless of technological improvement. Will a policy based less on legislation and more on persuasion work? One will have to wait to see whether the population at large will accept the carrots and avoid the sticks.

*The views expressed in this paper are personal and do not represent those of the Environment Agency, nor the National Centre for Risk Assessment or Options Appraisal.*

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# Clean Air? Where? - Are We Moving in the Right Direction?

N.K. Woodfield<sup>1</sup>, J.W.S. Longhurst<sup>1</sup>, C.I. Beattie<sup>1</sup>, D.P.H. Laxen<sup>2</sup>

<sup>1</sup>Air Quality Research Group

<sup>2</sup>Air Quality Consultants Ltd.

*The majority of local authorities across the UK have completed their first phase of air quality review and assessment work but are their efforts reflected in the outcomes of the process thus far? Has air quality management been an effective mechanism for achieving our aspirations for clean air?*

The air quality community has come a long way since the start of the LAQM process in 1997. Every local authority across the UK, with few exceptions, can boast of having more qualitative and quantitative air quality data than ever before. With the emergence of more automatic monitoring stations, widespread advanced modelling underway, and more epidemiological studies providing evidence for health impacts, so our confidence increases in the notion of widespread improvements in public and community well being, health and involvement.

Or does it? Have the last few years of intensive monitoring and modelling activity, and consultation been sufficiently effective to ensure the ultimate aim in complying with the air quality objectives? Clearly, the effort on the part of local government, central government and the wider air quality community has to date been focused on scientific processes to address potential air quality objective exceedences with respect to public exposure. As air quality management areas (AQMA) are designated, so the next and perhaps most important challenge emerges - actions to secure improvements. This paper reflects upon the outcomes of the first phase assessment work, and considers some of the more challenging aspects of improving local air quality.

## First Phase Challenges

By December 1999, the first official deadline for concluding the first phase work, less than 10% of local authorities in the UK had been able to complete their air quality assessment work, and by July 2000 only 12% had completed the task. Much of the official guidance for local government was revised during Spring 2000, causing some authorities to delay their process; the review of the UK Air Quality Strategy and subsequent changes including the introduction of new objectives have also caused delay to the process.

As the first phase assessment process has unfolded over the last two years, issues have emerged, which have caused our preconceived ideas as to the spatial extent of air quality problems to be critically challenged. Motorways and some major highways, long recognised as a major precursor of localised air quality problems are emerging as being less

problematic. Evidence suggests they are unlikely to exceed an objective unless sensitive receptors are very close to the road and the background is sufficiently elevated such as in London or other major centres. Local monitoring data to substantiate the claims of exceedences elsewhere as predicted by the sophisticated modelling, is often in short supply. In contrast to this, some localities expected to present few air quality problems are emerging as potential AQMAs. These are where the physical nature of the environment and congestion is sufficient to cause localised hot spots, even though traffic flows are below the value of 20,000 veh/day, as referenced in the early guidance.

Challenges facing local authorities implementing the air quality management process have been varied. Problems have included financial constraints within local government, the mis-timing of the Local Transport Plan process in relation to the extended review and assessment timetable as well as more practical issues of availability of monitoring equipment. Other important issues have included the treatment of uncertainty within monitoring and modelling results as well as in communicating the results of the review and assessment to the public and communicating the scientific assessment to political decision-makers.

## AQMAs Patterns Emerging - Areas for Everyone

Individual authorities have sufficient scope to declare their AQMAs at various spatial scales, using a variety of appropriate boundaries. This is reflected in the huge diversity of areas designated (officially and anticipated), in different parts of the country, and indeed between neighbouring authorities. By the end of December 2000, only 14 local authorities (of which 8 were London Boroughs) had declared AQMAs, of which 5 were borough-wide declarations. Of those areas designated to date, almost all (13 authorities) have local roads as the main contributor to exceedences, as anticipated. Perhaps not anticipated is the number of individual authorities having to designate - the number of authorities declaring may reach over 100 in due course.

## Clean Air - A Bumpy or Smooth Ride?

Implementation of the Air Quality Strategy<sup>1</sup> has for many local authorities been welcomed and accepted, whilst for some the process has been overly complex, burdensome and somewhat demanding. Amendments to the objectives, target dates and deadlines, coupled with the revision of

guidance, whilst undertaken to ensure the most current thinking drives the LAQM process, has been the cause of much irritation. Added to this are the financial and resource constraints felt by some, and the necessary impact of the management process on planning processes within and external to local government.

Some recent research results from a study of AQMA decision-making underway in the UK<sup>2</sup> identifies a number of concerns with respect to declaring AQMAs, from planning and other colleagues within local authorities. Over 75% of non-EHO personnel considered the potential blight of property within an AQMA to be a major concern with designating an AQMA, with only 6% admitting to having no concerns at all.

The interpretation of modelling results, and the subsequent translation of the scientific outcomes of the assessment process to declaring and demarcating AQMAs is an issue causing anxiety amongst the air quality profession. From the study, 56% of planning and other local authority colleagues considered the scientific uncertainty of the tools used in the assessment process to be a major concern of the declaration process.

Of course the final decisions with respect to the spatial extent of AQMAs designated, and the boundaries to be used will not be based on the outcomes of the scientific assessment process alone. In many local authorities, though not all, local politicians and responses received during the consultation will influence the shape and extent of any such designations. With the principle of subsidiarity being at the heart of the local air quality management process, local circumstances are already reflected in the outcomes of the management process, and are likely to be more so as the process moves on to seeking local solutions to local air quality problems.

### Wider Involvement - Planning for Planners

The UK LAQM process has certainly had the effect of uniting Environmental Health professionals in their attempts to make the process as straightforward as possible. Forums and Working Groups have arisen across the country, with local authorities working collaboratively with their neighbours to explore mechanisms for widespread consultation, develop modelling techniques and ensure a degree of consistency in aspects of the management process.

Strategic and development control planning have long been recognised as having a fundamental role in delivering clean air in the medium to long term. Local Development Plans, Structure Plans and Unitary Development Plans are important vehicles for promoting environmental protection through integrated land-use policies and provide the framework in which planning decisions are made. Air quality is a material consideration with respect to decisions on planning applications, and as such air quality has the potential to impact upon proposals for industrial, residential and commercial developments, not only where the impact is from the development directly, but also from traffic generated as a result of the development. The

outcome of the review and assessment process will provide the authority with the basic information to help assess the air quality implications of new developments.

A number of planning proposals in the UK have attempted to test air quality considerations as a material consideration through the planning process. The first such case was a proposed retail development in Bath and North East Somerset in 1998. More recently, a large residential development proposal, located in close vicinity to a motorway was overturned on grounds that included that predicted air quality concentrations would pose a threat to would-be residents. This clearly has implications for air quality action plans, which should include policy measures to ensure that potential developments in AQMAs are sensitive to potential exposure of existing or future residents.

From other research undertaken at UWE<sup>2,3</sup>, it is clear that transport planners are more involved in the AQM process than are land-use planners, economic development officers or Local Agenda 21 (LA21) officers. They are more likely to involve air quality within their strategic planning process, are more likely to use air quality information available to them, are more likely to be involved in regional groupings addressing air quality issues and have greater levels of training and awareness. This difference is likely to have been brought about as a response to pressure from central government through initiatives such as Integrated Transport. Land use planners are not as involved in the process as they might be at this stage. Although they have reasonable presence in internal groups within their authority addressing air quality issues, they do not appear to be involved at a regional level. LA21 officers are in an ideal position to develop partnership approaches to air quality review and assessment in a local authority. However, many authorities are missing this opportunity.

### Action Planning - The Way Forward

Air Quality Action Plans (AQAPs) provide the mechanism by which local authorities, in collaboration with national agencies and others, will state their intentions for working towards the air quality objectives through the powers they have available. As such, an effective AQAP will rely heavily on the integration of a variety of policy packages, not only those within local government, but also within regional plans and external agencies plans and policies. Research has indicated that within various professions (local government, regional agencies etc) policy integration to the level that is required is not, at present, occurring in urban areas of England to the extent that will be required<sup>2</sup>.

In developing an AQAP, an important consideration is that of cost effectiveness of solutions to deliver the objectives specified in the AQAP. This requires a clear understanding of the relative contributions to the air quality objective exceedences within the AQMA, so as to apportion the necessary responsibility for developing solutions between industrial, transport and other sectors effectively. Apportionment is of paramount importance before dialogue between the various stakeholders is undertaken, and the

cost effectiveness of potential solutions must take into account local circumstances<sup>4</sup>. A great deal of work investigating the effectiveness of various measures will be required.

The importance of effective communication, collaboration and consultation to underpin the decision making process has been identified. Action plans will inevitably be determined by local circumstances, and may focus on measures external to the designated AQMA. For instance, where an AQMA is predominantly traffic related, any measures implemented through the AQAP are likely to have wider transport impacts, for example on commuter journeys, which highlights the need for local authorities to work regionally.

In addition, in assessing the options available for inclusion within an AQAP, it is important that, where possible, local authorities consider socio-economic and wider environmental impacts arising from the options and measures. This will contribute to a local authority's achievement of sustainable development objectives, and will assist with the emerging development of Community Strategies for promoting improvements in the social, economic and environmental well-being of the area. Issues such as social equity, climate change, noise, waste management, accessibility may all have synergy with measures proposed in the AQAP.

It is worth noting that for the majority of local authorities, their initial review and assessment will indicate that an AQMA is not required. For some authorities the margin by which they avoid exceeding the objectives will be small, while for others a commitment to improving air quality will have been adopted as part of a corporate policy or Local Agenda 21 strategy. These authorities may be keen to implement a Local Air Quality Strategy (LAQS). Indeed, the Government encourages the development of LAQSS. The format of LAQSS can be far more flexible than AQAPs, and the intention of some regions of the country is to implement a Regional Air Quality Strategy (RAQS) in order to tackle regional air quality issues.

## Conclusions

So has the huge effort of local authorities and stakeholders provided an effective framework within which significant improvements to local air quality can be achieved in the UK? It is probably too soon to comment on whether measures to be put in place through action planning over the next few years will secure the necessary improvements in air quality. Clearly the LAQM process has been the catalyst for a significant increase in the number of national and local monitoring stations and number of pollutants routinely monitored, as well as a major improvement in the geographical coverage of UK monitoring. In addition, significant advances in the use of sophisticated modelling

software, coupled with a high quality national air quality archive of monitoring data and emissions inventories for major conurbations have been developed to help local authorities in carrying out their air quality duties. Extensive web based air quality resources have also been sponsored by DETR to support the LAQM process. An increase in political awareness of air quality issues and of the role of planning, development and transport policy could also be argued to be a direct consequence of the LAQM process, with increased local public awareness expected as AQMAs are designated and AQAPs developed.

Reviews of the National Air Quality Strategy; new objectives and updated guidance have generally been seen by local authorities as 'moving the goalposts' and hence detrimental to the process. The constant reviewing of the Strategy and objectives (and consequently the guidance) reflects the evolving LAQM process as technological and scientific advances, improved air pollution modelling techniques and increasingly the economic and social issues involved are better understood. Subsequent reviews of the national Strategy will allow the UK to implement emerging EU Daughter Directives and encompass new pollutants (such as mercury, arsenic and PAHs), which have potentially chronic or acute impacts on human health.

The foundations for clean air across the UK have now been laid and a period of real gains can be expected to follow. A sophisticated regime of air quality management has been developed, based on the fundamental principle of subsidiarity, with local government and ultimately their local communities being the key to future improvement of local air quality.

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# Particle Characterisation in an Active Limestone Quarrying Area of Portland Bill - A Cost Effective Approach for Local Authority PM<sub>10</sub> Assessment

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*An investigation into the nature and extent of PM<sub>10</sub> was carried out on the Isle of Portland for the Borough to augment the Local Authority Review and Assessment 2000. It was expected in this area of historic and present-day limestone quarrying that calcium carbonate particles would, if not dominate the loadings, constitute the major fraction of the coarse PM<sub>10</sub>. Particle characterisation demonstrated, however, that limestone occurred on an occasional basis with only two samples recording relative frequencies in excess of 4% of the non-soot insoluble fraction. It could therefore be concluded that the limestone quarries monitored did not produce an impact on PM<sub>10</sub> size dust. In addition, on the two occasions when there were slight increases in the relative frequency of carbonate, the total mass concentration values were both quite low, recording mean values below 25µg/m<sup>3</sup>, i.e. well below the UK National Air Quality Limit of 40µg/m<sup>3</sup>. Incorporating a particulate characterisation approach in the Portland PM<sub>10</sub> assessment resolved a long running cause of anxiety for the authority and the local residents and released resources for other pressing projects.*

## Introduction

Unsurprisingly, from time to time, Weymouth and Portland Borough Council has received complaints on dust allegedly arising from the limestone quarries of Portland Bill, a compact area of historic and intense exploitation of building stone. In 1996 the local authority commissioned a dust characterisation study to pinpoint the origins of the dust (Merefield and Roberts, 1996). The majority of the dust was deemed to come, not from the blasting as perceived, but from resuspended material due to traffic on the quarries' internal haul roads. This information proved useful in persuading the quarry operators to increase their water supplies; to enable more damping down of road surfaces in dry weather, to tarmac the permanent exit roads, and to improve wheel-washing facilities. Subsequently, the need to complete air quality review and assessments has necessitated revisiting the problem, but this time by characterising the finer PM<sub>10</sub> fraction.

## Background

The Isle of Portland is home to Portland Stone from which much of the square mile of the City of London including St Paul's Cathedral is built. A history of limestone exploitation has resulted in numerous quarrying enterprises on the island. The situation is unique, as most quarrying areas have houses within a few hundred metres, and some within 50 metres of the quarry boundaries. On Portland the closest houses have their rear gardens along the boundary of the quarry planning permissions. Most of the quarries are more or less encircled by housing. As a result, therefore, from time to time the Borough Council has received complaints about dust from the quarries.

As particle characterisation was seen as the key requirement of the assessment, specialists in this technique, Advance Environmental, were thus contracted by the Weymouth and Portland Borough Council to monitor ambient PM<sub>10</sub> concentrations. A property in Weston Street, Portland, Dorset was chosen as the site for this investigation. It was considered representative of the residential properties in the area as Hanson Aggregates' Perryfields limestone quarry is located approximately 100m to the east with Coombe Field Quarry located 200m southwest. Monitoring was undertaken between 10 August and 1 December 1999, during which a total of 77 days sampling was achieved. A selection of the resultant samples collected during monitoring were analysed in order to determine the impact of local, regional and transboundary inputs of particulate matter.

## Methods

### Sampling

The method of PM<sub>10</sub> sampling employed for this assessment used a Rupprecht and Pataschnick Partisol Plus 2025 sequential sampler. This was configured to collect PM<sub>10</sub> for three discrete sampling periods: twenty-four hour sampling for 2 weeks, followed by 96 hour sampling for approximately 8 weeks, followed by a further 2 week period of 24 hour sampling. The 24 hour methodology adopted was that adopted for the UK National Air Quality Strategy and the EU Air Quality Daughter Directive. Whilst 24 hour sampling can provide adequate material for characterisation, the 96 hour samples resulted in an excess of material which could be

readily used for characterisation if total sample mass concentrations were low.

### Sample preparation

Aqueous soluble particles were extracted from the samples using a vacuum filtration unit. This consisted of a 100ml Buchner flask, 47mm sintered glass filter support, reservoir and a hand pump. The 47mm diameter glass fibre filters and their samples were placed upon the sintered glass support and clamped in place with the reservoir. These were attached to the Buchner flask and hand pump. A total of 40ml of deionised water at 40°C was used to wash soluble salts from the filter. The method used in extracting aqueous soluble salts ensured samples had sufficient exposure to water for total extraction, but an insufficient period in which to disturb the insoluble particulate component. This allowed the examination of individual insoluble particles (Stone et al 1996, Merefield et al 1998). Filters were mounted onto aluminium stubs with conductive adhesive and were gold coated. Discrete particle size and morphology were determined using a Philips 505 Scanning Electron Microscope (SEM). Discrete particle chemistry and identification was achieved using the SEM in conjunction with an EDAX 9900 Energy Dispersive X-ray Spectrometer (EDS). The EDS used a super-ultra-thin window detector which allowed the analysis of light atomic weight ( $Z > 5$ ) elements (Merefield et al 1999; 2000).

### Analysis

Particulate matter samples were characterised for particle type, size and relative frequency using Scanning Electron Microscopy with Energy Dispersive X-ray Spectrometry (SEM/EDS). This semi-quantitative methodology allowed discrimination between different types of particulate matter and thereby apportionment of likely sources. This methodology has been used to assess particulates from the insoluble fraction such as limestone and flyash (Merefield et al 1999; 2000).

In addition to the above, PM<sub>10</sub> samples were also subjected to a quantitative assessment of water soluble material. This total characterisation involved the extraction of water soluble PM<sub>10</sub> and its subsequent quantitative analysis. This determined sulphate, nitrate and chloride anions, and sodium, potassium, calcium, magnesium and ammonium cations. These tend to represent regional and transboundary material but can also be derived from local combustion sources and marine salts, usually at coastal locations. The resultant data provides the percentage mass and mass concentration of the ions which can account for a considerable component of PM<sub>10</sub>.

### Results

Mass concentrations of PM<sub>10</sub> are given in Table 1 along with data on limestone, flyash, soluble components and prevailing wind directions. In summary, the mean PM<sub>10</sub> mass concentrations for the entire study was 20.9 µg/m<sup>3</sup>, with a maximum value of 41.7 µg/m<sup>3</sup> and a minimum value of 7.92 µg/m<sup>3</sup> and thus they all fall within the objective set by the UK National Air Quality Strategy and EU Air Quality Daughter Directive (DETR, 2000).

In general, the highest mean mass concentration of PM<sub>10</sub> occurred when the wind was predominantly derived from the east. Characterisation identified these maxima which were associated with elevated levels of iron flyash spheres, occasional alumina-silicate flyash spheres (Table 1 & Figure 1) and various aqueous soluble material (Figure 2). It can therefore be inferred that these primary and secondary particulate matter were transboundary, probably originating from mainland Europe.

Particle characterisation demonstrated that limestone particles occurred on an occasional basis with only two samples recording relative frequencies in excess of 4% of the non-soot insoluble fraction. It can therefore be concluded that these limestone quarries did not produce an impact on PM<sub>10</sub> size dust during the study period. In addition, on the two occasions when there were slight increases in the relative frequency of limestone, the total mass concentration values were both quite low, recording mean values below 25 µg/m<sup>3</sup> (Figure 1).

Sodium chloride, or sea salt, frequently dominated the aqueous soluble material, but sulphates and nitrates also had their periods of dominance. In general, sea salt showed elevated values when the wind was from the west (Table 1). Indeed, the second highest total mass concentration included sea salt which accounted for approximately 16 µg/m<sup>3</sup> out of a total mass concentration of 41 µg/m<sup>3</sup>. Much of the elevated sulphate and nitrate material was derived from the east, confirming the regional or transboundary nature of the PM<sub>10</sub> collected at this location (Figure 3).

### Effectiveness

It has thus been drawn rather forcibly to the Borough's attention that monitoring without knowledge of exactly what is being monitored, does not enable the drawing up of an effective action plan, because the regulator cannot be sure of what is requiring control. Without this information, should it have been necessary to continue to Stage III, the Borough would be desperately seeking a solution to the "dreadful problem" of "PM<sub>10</sub> from these quarries", which is now known not to exist.

As it is, the authors are able to state with confidence that the quarries are not a significant source of PM<sub>10</sub>. As small particles can be transported over great distances, it is vital to know which fractions of the total are of local origin, which are not, and which of the local sources are significant. Ultimately this leads to the development of potential abatement methods and the all important action plan.

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**Table 1.** Comparison of Weather with Particle Type

Date/Period	Sample mass conc. (µg/m <sup>3</sup> )	Predominant wind direction*	Fe flyash % relative frequency	AlSi flyash % relative frequency	Limestone % relative frequency	Cl (µg/m <sup>3</sup> )	NO <sub>3</sub> (µg/m <sup>3</sup> )	SO <sub>4</sub> (µg/m <sup>3</sup> )
20/08/99	37.5	<b>e</b>	41	4	0	0.33	3.10	2.96
21/08/99	25	<b>ese</b>	4	8	11	1.18	2.30	2.57
22/08/99	25	<b>e</b>	3	2	2	2.73	2.82	3.19
23/08/99	41.7	<b>ese</b>	26	4	4	3.23	4.30	3.29
24/08/99	33.3	<b>e</b>	33	4	0	1.58	8.22	3.72
25/08/99	12.29	<b>e to wsw</b>	1	5	2	0.21	1.31	2.58
4-8/10/99	13.23	<b>e to w</b>	31	6	2	1.16	1.60	2.24
8-12/10/99	13.02	<b>w to ene</b>	24	12	2	2.25	0.94	1.44
12-16/10/99	35.73	<b>ene to e</b>	26	13	0	1.05	6.59	4.35
16-20/10/99	37.81	<b>e</b>	13	11	4	1.72	5.54	3.86
20-24/10/99	26.46	<b>e to sw</b>	36	13	2	5.07	1.84	2.06
24-28/10/99	16.04	<b>nw to sw</b>	10	4	1	1.67	2.36	1.57
28/10-1/11/99	30.31	<b>e to sw</b>	6	13	1	4.55	2.52	2.83
1-5/11/99	20.73	<b>sw to wnw</b>	3	9	0	4.31	1.25	1.41
5-9/11/99	12.81	<b>ssw to ne</b>	3	13	1	1.89	1.62	1.23
9-13/11/99	19.38	<b>ne to e</b>	10	14	0	1.13	3.81	2.85
13-17/11/99	14.27	<b>e to nw</b>	4	27	2	1.39	1.64	1.31
26/11/99	20.83	<b>wsw</b>	3	20	0	5.23	1.28	2.44
27/11/99	20.00	<b>w</b>	2	5	4	4.66	0.37	0.91
28/11/99	40.83	<b>ssw</b>	3	20	3	10.41	2.62	4.11
29/11/99	11.67	<b>ne</b>	3	5	0	2.20	1.02	1.01
30/11/99	13.33	<b>w</b>	5	15	8	4.65	0.65	0.97

\*Bold type equates to dominant wind direction

Figure 1. Mass Concentration of PM<sub>10</sub> and Relative Frequency of Limestone and Spherical Flyash

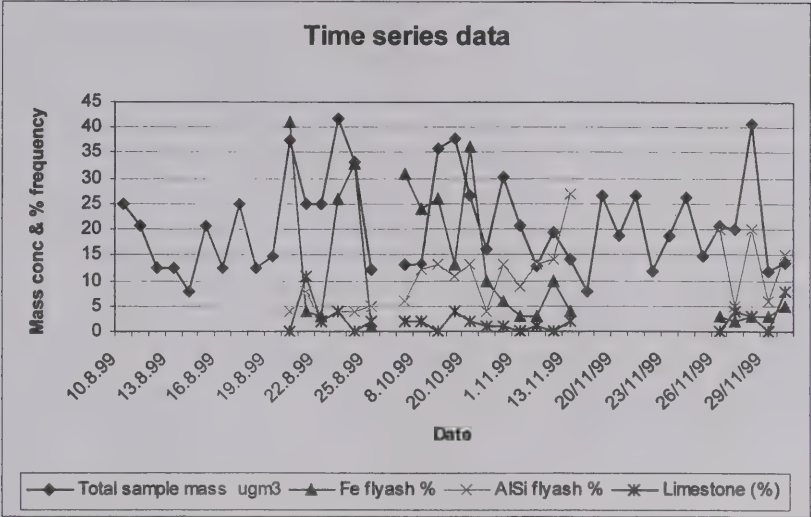


Figure 2. Time Series Mass Concentration of PM<sub>10</sub> and Total Mass Concentration of Aqueous Soluble Material

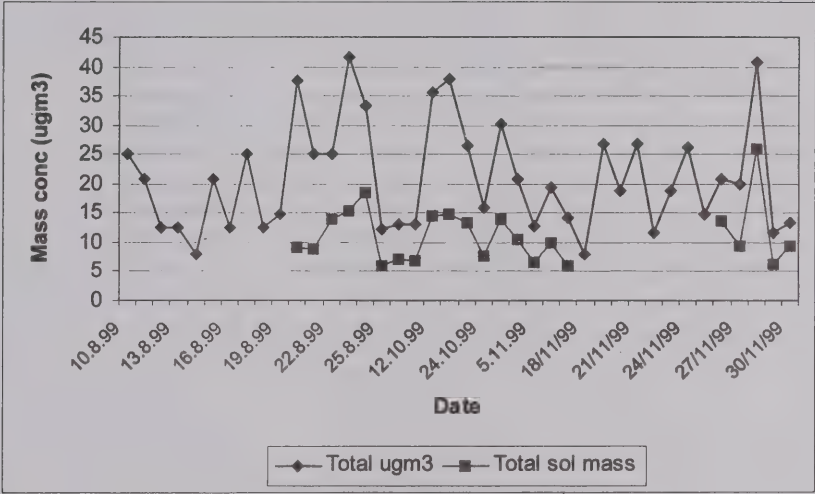
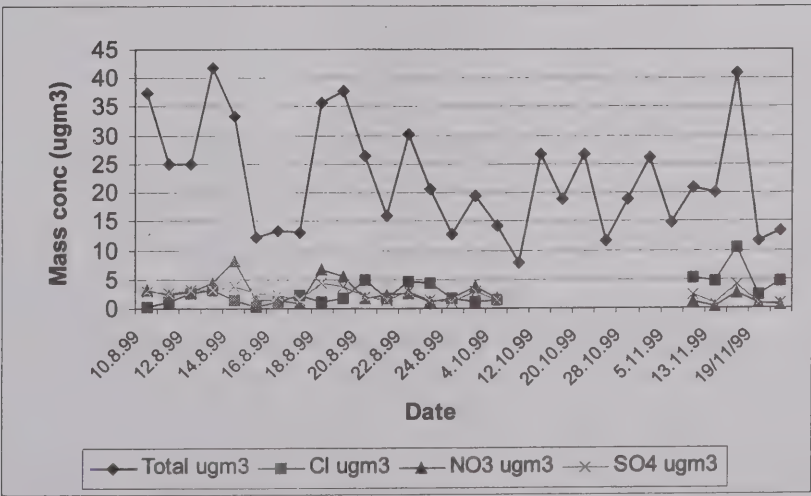


Figure 3. Time Series Mass Concentration of PM<sub>10</sub> and Total Mass Concentration of Aqueous Soluble Anions



# Incineration of Household Waste

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*Recent national waste strategies have led to the suggestion that the numbers of waste incinerators may increase significantly. This raises concerns over the health effects of pollution and the role of incineration in waste management.*

### Background

Each year UK households generate around 30 million tonnes of municipal solid waste (MSW)<sup>1</sup> (Table 1). The Department of the Environment, Transport and the Regions (DETR) reports that this figure appears to be growing at about 3% per year. Management of MSW in the UK is dominated (83%) by landfill disposal (Table 1), with less than one tenth either incinerated or recycled<sup>2</sup>.

There are 13 MSW incinerators (MSWIs) operating in Britain (there are none in Northern Ireland), burning around 2 million tonnes of MSW each year (8% of the total). All MSWIs recover some of the energy from combustion as electricity or in district heating. As such, these facilities are known as 'energy from waste' (EfW) or 'waste to energy' plants. Current facilities range in size from a plant in Lerwick, handling 26,000 tonnes per year (26kt/yr) and producing heat for a local district heating system to a 600kt/yr facility at Edmonton, generating 30 megawatts (MW) of electricity. Over half of all current incinerators handle more than 200kt/yr, and 40% between 100 and 200kt/yr.

MSWIs operate by feeding wastes onto a moving grate where they are burned. The heat generated raises steam, driving turbines to generate electricity. The burning of the waste gives rise to:

- solid **incinerator bottom ash** (up to 25% of the weight of the MSW) - which falls to the bottom of the grate for collection. This is either disposed of to landfill or reused in construction.
- a very much finer **fly ash**, caught up in the flue gases (air and gaseous combustion products).

Box 1 outlines the current technology for waste incineration, and the main developing technologies. Information provided by the Energy from Waste Association (EWA) shows that additional incinerator capacity of ~4 million tonnes/yr is currently being considered - more than doubling existing capacity (Table 2).

**Table 1.** Waste Treatment in the UK

Region	M S W (million tonnes/ yr)	Landfill	Recycling and reuse	Incineration
England & Wales	28	82%	10%	8%
Scotland	3	90%	5%	5%
N. Ireland	1	95%	5%	0%
Total	32	83%	9%	8%

Sources: DETR, Scottish Environment Protection Agency, Environment and Heritage Service Northern Ireland

### Box 1. Waste Incinerator Technology

*There are four main technologies for the incineration of waste:*

**Mass Burn** – This is currently the simplest and most common form of incineration. Mixed wastes are fed into a hopper and then fall onto a sloping grate which agitates and moves the waste through the combustion chamber. Energy is recovered from the hot combustion gases, which is used to generate around 7MW of electricity per 100,000 tonnes of waste (enough electricity to serve around 10,000 homes).

**Fluidised Bed Combustion (FBC)** – Before the waste is incinerated, non-combustible components are removed and the waste shredded to produce coarse Refuse Derived Fuel (cRDF) which has a higher calorific value than the untreated waste. The cRDF is fed into a bed made up of a mixture of sand and dolomite mineral. Air is pumped through the base so that the solid waste and minerals resemble a bubbling liquid. This 'fluidisation' improves the combustion efficiency, hence reducing pollution and generating more energy per tonne of waste. However, the process is between 25% and 35% slower than mass-burn. To date there has been limited experience with using FBC for municipal waste incineration, and the performance of this technology has not been proven on a commercial scale. In Berlin, a new FBC waste incinerator has been closed down because of reliability problems.

**Pyrolysis and Gasification** – These novel technologies have had limited experience in treating municipal waste. Wastes do not need sorting, but must be crushed, and this pre-treatment leads to higher costs and uses more energy. **Pyrolysis** involves heating waste in the absence of oxygen at temperatures of 400-800°C. The heat alone breaks down complex molecules and the resultant gases are then passed into a combustion chamber where they are burned (in the presence of oxygen) at temperatures around 1250°C. **Gasification** involves heating wastes in a low-oxygen atmosphere to produce a gas with a low energy content. This gas can then be burned in a turbine or engine. There are only a few pilot pyrolysis and gasification plants worldwide - in Japan and Germany - but the technology has not yet been proven to be commercially viable. A pilot scale gasifier is being built in Bristol with a capacity to burn 9kt/yr of MSW.

<sup>1</sup>The total for municipal, industrial and commercial wastes is ~ 70 million tonnes.

<sup>2</sup>Many countries recycle and incinerate a larger proportion of waste than the UK.

Pollutants from Incineration

The main pollutants of concern are dioxins, acid gases, nitrogen oxides, heavy metals and particulates (Box 2). These are present in bottom ash, fly ash and combustion gases<sup>3</sup>, although flue gas cleaning reduces pollutant emissions to the air to a large extent. Fly ash can contain sufficient dioxins and metals to require it to be treated as a hazardous waste. However, it is the presence of pollutants in the gases emitted from MSWI chimneys that attracts most concern, and in particular, the presence of dioxins (Box 3) because they are suspected of causing cancer and are widely distributed throughout the food chain.

Of other air pollutants, acid gases and particulates, for instance, can harm people with respiratory illnesses. A report<sup>4</sup> from the Department of Health’s Committee on the Medical Effects of Air Pollution (COMEAP) concluded that PM<sub>10</sub> pollution from all urban sources hastens (‘brings forward’) 8,100 deaths/yr, and increases or brings forward hospital admissions by 10,500/yr.

Table 2. Energy from Waste Plants in the UK

Status (as at Feb 2000)	waste capacity (kt/yr)
Operating (or being upgraded)	2,706
Under construction or planning granted	790
Firm contract subject to planning	1,285
Proposed	1,630
Total	6,411
% increase in capacity relative to current operating (and upgrading) capacity	137%

Source: Energy From Waste Association

Box 2. Main Pollutants from Waste Incineration

<p><b>Gases</b> – acidic gases (such as hydrogen chloride, hydrogen fluoride and sulphur dioxide), and other gases such as nitrogen oxides, carbon monoxide and carbon dioxide.</p> <p><b>Metals</b> – in particular cadmium, mercury, arsenic, vanadium, chromium, cobalt, copper, lead, manganese, nickel, thallium, tin. These are present as soluble compounds (such as chlorides and sulphates), and less soluble compounds (such as oxides and silicates). Mercury, and some cadmium, is released as vapour.</p> <p><b>Organic substances</b> – these are often present where combustion has not been complete, or are formed after incineration has occurred. The organic compounds may be released as vapour or bound to particulates. Dioxins are the organic pollutants that attract most concern (Box 3).</p> <p><b>Particulate matter</b> – fine particles (often of inorganic materials such as silica), frequently with metals and organic compounds on their surfaces. They vary greatly in size, but recently, concern has focussed on ultrafine particles of less than 10 millionths of a metre (10 microns) – these are known as PM<sub>10</sub>.</p>
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<sup>3</sup>There are also pollutants present in liquid effluents arising from gas cleaning and ash cooling equipment.

<sup>4</sup>The Quantification of the Effects of Air Pollution on Health in the United Kingdom. <http://www.doh.gov.uk/hef/airpol/airpol7.htm>

<sup>5</sup>In its 17<sup>th</sup> report (1993), the Royal Commission on Environmental Pollution calculated that incineration with energy recovery is a net emitter of greenhouse gases (carbon dioxide). However, it showed that, compared with landfill (which produces methane and carbon dioxide), incineration reduces overall greenhouse gas emissions.

Regulating Incinerators

The Environment Agency (EA) in England and Wales, and the Scottish Environment Protection Agency (SEPA) regulate releases to the environment from MSW incinerators under the integrated pollution control (IPC) regime. Releases must be prevented, or reduced to a minimum using the ‘best available techniques not entailing excessive cost’. When authorising processes, the EA and SEPA impose limits on a range of substances released to air, water and land, together with conditions on operation (e.g. regular monitoring). MSW incinerators were first authorised under IPC in 1993, and new EU standards imposed in 1996, resulting in the closure of many older incinerators.

A new EU waste incineration directive (agreed in 2000), introduces tighter standards, including an emission limit on dioxins of 0.1 nanogrammes<sup>6</sup> of TEQ per cubic metre of exhaust gas (ngTEQ/m<sup>3</sup>) – equivalent to 100pgTEQ/m<sup>3</sup> (Box 3). The incineration directive requires that new incinerators comply with the standards from 2003 and existing plant from 2006<sup>7</sup>.

The siting of incinerators is regulated under the land use system, where the operator must obtain permission from the local planning authority. In determining the planning application, the local authority must have regard for, among other things, environmental impacts, and hence requires the developer to produce an environmental impact statement. In addition, the local authority will consult the environmental regulator (EA or SEPA). The recent Pollution Prevention and Control Regulations will require closer coordination and consultation between the environmental regulators and local authorities responsible for land use control. Increasingly, local authorities are developing waste local plans in a regional context, taking account of regional planning guidance.

Issues

Waste Management Policy

The Waste Strategies for England and Wales and for Scotland, have led to concerns that the number of incinerators across Britain will increase. Indeed, the Department of the Environment, Transport and the Regions has calculated<sup>8</sup>, based on a range of waste management scenarios, that anywhere between 28 and 165 new average-size incinerators may be needed over the next 20 years in England and Wales<sup>9</sup> to meet targets for diverting wastes from landfill set out in the EU Landfill Directive.

DETR regards the high end of this range to be unlikely, and evidence to the Commons Environment Sub-Committee from the EWA and from Enviros consultants suggests that up to around 50 new plants will be needed by 2015. The precise final figure will depend on trends in waste production, success of reduction, reuse and recycling schemes and size of plant.

<sup>6</sup>1 nanogramme is one billionth of a gramme

<sup>7</sup>most UK MSW incinerators comply with these standards, but upgrades will be necessary for many to comply with emission limits on nitrogen oxides.

<sup>8</sup>House of Lords European Union Committee 7th report Session 1998/99 (para 101).

<sup>9</sup>There are no comparable figures in the waste strategy for Scotland.

### Box 3. The Hazards of Dioxins

**What are they?** Dioxins is the name given to a group of 210 similar chlorinated organic chemicals.

**Health Effects** – Dioxins may cause adverse health effects, depending on the level, timing, duration and frequency of exposure, the particular compounds, and the susceptibility of the person exposed. Most concern is expressed over the link between long-term exposure to dioxins and the risk of cancer. Studies have also suggested dioxins may cause reproductive or developmental effects, e.g. abnormal physical development, weakened immune responses and behavioural changes.

**Standards** – It is unclear whether there is a threshold below which exposure to dioxins will have no effect. The US Environmental Protection Agency (US EPA) assumes that no such threshold exists and sets precautionary standards accordingly. The World Health Organisation (WHO) and the UK Department of Health's advisory committees<sup>10</sup> assume there is a 'no-effect' threshold, and thus set slightly less stringent standards (see below). Standards for allowable levels of dioxins in foods are based on the concept of 'tolerable daily intakes' (TDIs). Because different dioxins vary in their toxicity, standards are also expressed in terms of toxic equivalents (TEQ). A TEQ of 1 relates to the most toxic dioxins – others have lower TEQs. US EPA uses a TDI of 0.1 picogramme<sup>11</sup>/kilogramme body weight/day (pgTEQ/kg.bw/d), whereas the WHO recommends a TDI of 1–4pgTEQ/kg.bw/d. The UK standard is currently 10pgTEQ/kg.bw/d, but is being reviewed.

**Exposure** – 98% of people's exposure to dioxins comes through the food chain (direct inhalation accounts for the remaining 2%). In 1997 (the most recently available data), 3% of dioxin emissions came from MSW incinerators. Dioxins are deposited from the air onto crops, grazing land and soil, and are passed through the food chain to be ingested. They are also washed off the land into the sea and taken up by fish. They are widespread in the environment, and minute levels are likely to be found in all foods. However, exposure may increase because of people's proximity to particular sources, or through dietary habits – e.g. a large consumption of oily fish, red meat, dairy produce, or breast milk for nursing infants. Because dioxins are chemically inert, they are not readily broken down and can accumulate in the body (particularly in fatty tissues).

Current levels of exposure may be sufficient to cause some adverse impacts in the general population, although research has found no clear evidence of this. Both the US EPA and WHO acknowledge that such effects may be occurring but are not observable because they are 'masked' by the background of 'normal' disease. Studies investigating health effects and dioxin exposure in specific locations (e.g. the area surrounding waste incinerators) have also yielded inconclusive results.

Sources: US EPA, WHO, COC, COM.

An important element in UK waste management policy is the 'waste management hierarchy'. This prioritises waste management options, so that the option with the lowest environmental cost should have first refusal. As such, the first priority is to minimise the production of waste, followed by reuse, recycling and recovery, and finally disposal. In this hierarchy incineration with energy recovery needs to be

considered before landfill. The Waste Strategy for England and Wales makes it clear that waste incineration without energy recovery will be regarded as disposal, effectively requiring any incinerator proposal to include it. The strategy signals that incineration may form part of a comprehensive waste management package but that local authorities should sanction the use of waste incineration only where options higher in the hierarchy have been exhausted and where energy recovery can provide a benefit in terms of locally-supplied electricity, district heating (or both).

Overall, waste management is founded on developing a mix of waste management options that represents the Best Practicable Environmental Option (BPEO). This means that the environmental impacts of a local authority's waste plan should be minimised within the bounds of technical and economic feasibility. However, it is not made clear in the Waste Strategy how the BPEO for waste management should be identified.

There is a range of opinion among environmental campaigning groups<sup>12</sup> regarding the place of incineration in waste management. The National Society for Clean Air and Environmental Protection argues for incineration to play a part in a comprehensive strategy that includes waste reduction, reuse and recycling. Waste Watch agrees, but wishes to see these other options maximised before adopting incineration. Concerns remain, however, that there is no definitive guidance on how waste planning authorities can prove that options higher in the hierarchy have been exhausted before adopting incineration.

Other groups (e.g. Greenpeace and Friends of the Earth) argue that there is little or no place for incineration in waste management. They allege that the pollutants released present an unacceptable risk to health and are concerned that commitment by local authorities to long-term contracts for supplying waste to incinerators will undermine efforts to reduce waste at source, and to recycle and reuse residual wastes<sup>13</sup>. Lastly, some groups reject the classification of energy from waste as a form of renewable energy – this is highly contentious, but is beyond the scope of this briefing.

## Regulatory Issues

### *The Role of the Environmental Regulator*

The potential impacts of pollutant releases on health raise concerns, most often related to whether there is a 'safe' dose of dioxins. While the International Agency on Cancer Research (IARC) classifies dioxin as carcinogenic to humans, uncertainty remains over how dioxin causes cancer, and at what level it may be carcinogenic or have other effects. Recognising this uncertainty, the EU adopted a precautionary approach in setting the dioxin emission limit value. But, this level has not been set on the basis of an assessment of what might be considered a 'safe' dose – i.e. it

<sup>10</sup>Committee on Toxicity of Chemicals in Food, Consumer Products and the Environment (COT), Committee on Carcinogenicity of Chemicals in Food, Consumer Products and the Environment (COC), and Committee on Mutagenicity of Chemicals in Food, Consumer Products and the Environment (COM)

<sup>11</sup>1picogramme (pg) is one trillionth of a gramme

<sup>12</sup>See evidence to House of Commons Environment Sub-Committee inquiry into Delivering Sustainable Waste Management, October 2000.

<sup>13</sup>However, there is evidence from overseas showing that recycling and incineration can occur within a comprehensive waste management programme – Petts, J., Planning for sustainable waste management, in Miller, C. (ed) Planning and the Environment, in press.

is not related to any specific TDI (Box 3). Instead, the limit was set so that reliable measurements can be made by available detection equipment.

This means that regulating emissions relative to the emission limit does not guarantee that emissions are at a safe level. Rather, regulation to protect health has to rely on mathematical models of the dispersion, deposition and uptake of dioxins, and the consequent levels of exposure in relation to the TDI. Each element in the model relies on assumptions and can introduce large uncertainties. This raises concerns over whether the setting and enforcement of standards, and process authorisation fulfil the Agencies' requirement to protect human health. However, modelling worst-case situations helps to take account of many uncertainties.

Critics of incineration have suggested that more than 500 deaths would be brought forward over the operating life of an incinerator. However, this figure has now been shown to be erroneously too high<sup>14</sup>. Even so, such an analysis, based on extrapolation of the COMEAP report would not produce an accurate figure for any specific incinerator, as it does not take account of local conditions, such as the:

- location of pollutant sources and those receiving the pollution.
- the pathways of exposure (e.g. the transport of dioxins through the food chain).
- how susceptible people are to particular pollutants (e.g. the old, young or infirm).

### *The Role of Local Authorities*

Local authorities produce statutory 'waste local plans', act as waste collection authorities, waste disposal authorities, and as local planning authorities. The Local Government Association (LGA) and the Planning Officers Society have expressed concerns that there is very poor coordination between these functions. This can be particularly acute where these responsibilities are split between counties (waste planning) and districts (collection, disposal and land use control).

### **Public Concerns and Acceptability**

Local opposition to incinerators is often strong. Concerns arise over whether an incinerator is:

- justified in relation to reduction, reuse and recycling of wastes.
- sited and sized appropriately – e.g. if it deals only with wastes originating locally, and if it is located in a deprived area (raising issues of environmental justice).
- regulated to sufficient environmental standards, and that these standards are enforced adequately – i.e. whether the regulator can be trusted as independent and competent.

Such concerns are frequently characterised as NIMBYism (Not in My Back Yard). However, research shows that

people's concerns often stem from the way that MSWIs are planned and consultation conducted. In particular, opposition arises when people feel excluded from decision-making and have decisions imposed upon them. Acceptability is increased if local people are involved early in planning (Box 4), including in the regional and waste local planning process. The DETR makes this point in recent guidance, and is fully supported by the LGA and the EWA, who now regard this process as the 'norm'.

#### **Box 4. Incinerator Planning and the Public**

Examples of including the public in decision-making include:

- **Dundee Energy Recycling Ltd** has signed the UK's first 'Good Neighbour Charter' committing the company to adopting environmental standards stricter than currently required by law.
- the **SELCHP** incinerator in southeast London, involved local people working with the developers and planners, and a member of the local community sits on the management board.
- Following a previously failed plan, **Hampshire County Council** set up a number of citizens' panels to examine issues related to waste in the county and has worked with them to develop a mix of options that includes composting, recycling and small-scale incineration. This plan has met with wider public acceptance.

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The Parliamentary Office of Science and Technology, 7 Millbank, London SW1P 3JA, tel: [020] 7219 2840. See also [www.parliament.uk/post/home.htm](http://www.parliament.uk/post/home.htm)

<sup>14</sup> following recalculation by consultants of the cost-benefit analysis in the DETR's Regulatory and Environmental Impact Assessment on the Proposed Waste Incineration Directive.

# Dioxin Measurement

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*Dioxins and related compounds (PCDD/Fs) have been associated with a range of health effects. A broad consensus has emerged that exposure to dioxins and dioxin like compounds are towards the upper limit of that which is desirable. In consequence governments have implemented a number of policies to measure and reduce the exposure of the population.*

*The great majority of human exposure to PCDD/Fs arises through the consumption of food and particularly food with a high fish or animal lipid content. Hence those individuals with diets with a high fish or animal fat content are likely to receive the greatest exposure. The contribution of direct exposure through air, water and soil is very limited. The most important exceptions are those children consuming significant quantities of soil and nursing infants. However it is widely accepted that the benefits to the child of breast feeding far outweigh the effects from the PCDD/F content of breast milk.*

*The impact of Integrated Pollution Control (IPC), in the future IPPC, is likely to continue the reductions in environmental releases of PCDD/Fs which have occurred throughout the 1990s. Emissions are estimated to have fallen from 1078 to 325g I-TEQ from 1990 to 1998.*

*Measurement of PCDD/Fs is costly. While national and international standards for sampling and analysis are becoming available, these do not describe when and where to sample. The study objectives of measurement programmes need to be carefully specified before work is undertaken.*

*Levels in air of PCDD/Fs have decreased greatly during the 1990s and will probably continue to fall. The emission sources controlling future exposure are less likely to be contemporary industrial emissions and will increasingly be environmental reservoirs such as soil and sediment.*

congeners which can occur for a given number of chlorine atoms. The sum of the compounds with the same number of chlorine atoms is also sometimes mentioned in analytical reports and is known as a congener group total and is referred to as, for example, 'total TCDD'.

Long term, exposure to these 17 compounds and the 12 dioxin like PCBs is thought to have a range of potential health consequences. The 2,3,7,8 chlorine substituted compounds have similar toxic effects but with widely different strengths. The most toxic compound is 2,3,7,8 tetrachloro dibenzo-p-dioxin (2,3,7,8 TCDD). The other 2,3,7,8 chlorine substituted compounds are up to a 1000 times less toxic but tend to be found in higher quantities in environmental samples. An internationally agreed weighting scheme, the International Toxicity Equivalent Factors (I-TEFs), has often been used to assess the toxicity of mixtures of dioxins by evaluating the quantity of 2,3,7,8 TCDD, which would have the same effect as the mixture. This quantity is known as the International Toxic Equivalent (I-TEQ). The Environment Agency presently uses I-TEQs for emission regulation.

In 1998 the World Health Organisation (WHO) reviewed the available information on PCDD/Fs and recommended that some of the toxic equivalence factors be revised. Further they recommended that those PCBs which have been shown to have dioxin-like toxicity should also be included in the total toxic equivalent. The new TEFs are known as WHO Toxic Equivalent Factors (WHO-TEF).

The majority of human exposure to PCDD/Fs arises from dairy products, meat and fish, primarily because these compounds are concentrated in fat. Recent studies of food levels suggest exposure to dioxins in the UK has reduced markedly from 4 pg I-TEQ / kg body weight / day in 1982 to 1 pg I-TEQ / kg body weight / day in 1992 assuming a 60 kg person consuming the average diet. The recommendation from the Department of Health was previously that the tolerable daily intake (TDI) for PCDD/Fs should not exceed 10 pg/kg body weight /day over a lifetime. In 1998 the WHO recommended that the TDI for dioxins, furans and PCBs should not exceed 1-4 pg WHO-TEQ/kg bodyweight / day as a life time exposure. This has now been generally accepted. While present exposure is below the TDI for the average person the range of diets within the population probably mean that exceedence of the WHO TDI occurs for certain population groups. Hence measures to control emissions will continue, combined with guidance as to how to prevent exposure through food.

A combination of regulatory control in the UK and internationally, voluntary measures and market forces in

## 1. Introduction

"Dioxins" is the name commonly used for a group of 210 organic compounds. These comprise the 75 polychlorinated dibenzo-p-dioxins and the 135 polychlorinated dibenzofurans. These contain between 1 and 8 chlorine atoms substituted around one of two base structures. The 17 compounds containing chlorine in all of the 2, 3, 7 and 8 positions are the dioxin compounds of toxicological importance for humans and so are analysed separately where possible. Increasingly 12 of the 209 polychlorinated biphenyls (PCBs) are being recognised as having dioxin-like toxicity and included in any assessment programmes for dioxin like risks. Table 1 shows the number of possible

the UK have reduced PCDD/F inputs into the environment. Since 1990 the implementation of the Environmental Protection Act has enabled the regulatory authorities (HMIP/HMIPI and now the Environment Agency/SEPA/NI DoE) to assess possible sources of dioxins and control them where necessary. Measures taken in the UK have greatly reduced the emissions from incinerators as incinerators using older technology are replaced with efficient combustion units with modern pollution abatement equipment. Other significant sources of dioxins include the metal industry, parts of the chemical industry, a range of combustion sources and traffic, particularly leaded petrol fuelled vehicles.

To measure exposure and quantify the routes through which PCDD/Fs are transported from source to food stuffs, measurements of PCDD/Fs are made. Operators and regulators both national and local, environmental and planning, involved in the development of new industrial installations such as incinerators which have become associated with dioxins, use measurement programmes to seek to demonstrate to a frequently reluctant local population the environmental impact of the new plant.

## 2. Physical and Chemical Properties of Dioxins

Selected physical properties of selected dioxins are given in Table 2. It can be seen from the table that PCDD/Fs are very insoluble in water. Hence when deposited to water bodies they have a strong tendency to concentrate in suspended or deposited sediments, or any biota present. They also have very limited volatility. In the atmosphere the PCDD/Fs with 4 or more chlorine atoms per molecule are associated with particles in the atmosphere. However the exact proportion is dependent on a number of factors; principally the available particle surface area, the nature of the particle surface and the temperature. The PCDD/Fs as shown by the log  $K_{ow}$ , are lipophilic. Octanol is used as a surrogate for lipid in this test. As PCDD/Fs are extremely persistent in a range of environmental media, and the 2,3,7,8 substituted congeners are not readily biologically degraded, this brings us to the heart of the problem with dioxins. They are persistent, they bioaccumulate and the risk at low exposures is not insignificant.

## 3. Sources of Dioxins

The development of the UK's PCDD/F emission inventory has been an interesting problem for the inventory scientist. Certain sectors such as sinter plant are frequently monitored leading to emission estimates of low uncertainty. In other sectors there is an absence of information from the UK and emission factors are possibly from one dated overseas reference. Hence when taking decisions based on the inventory the uncertainty should be considered.

Table 4 shows estimates for PCDD/F emissions for 1990, 1995 and 1998. Those emission sources which historically have been important are now tightly regulated. As a result industrial emissions of PCDD/Fs have fallen dramatically during the 1990s principally as a result of the closure in 1996

of the older municipal waste incinerators and their replacement by the modern generation of plant.

As more measurements are taken from a wider range of sources it becomes possible to include new sources in the inventory. For example for 1999 the UK National Atmospheric Emission Inventory will include emissions from burning vehicles for the first time and it is hoped to include shortly estimates for emissions from house fires.

## 4. Sampling

PCDD/Fs are present in the environment at very low concentrations; 10-100 fg I-TEQ/m<sup>3</sup> in air, 1-50 ng I-TEQ/kg in soil and perhaps 0.001-10 ng I-TEQ/m<sup>3</sup> in stack samples. Analysis of samples for PCDD/Fs and PCBs will cost several hundred pounds per sample. Hence when designing a sampling programme in order to maximise its economic efficiency it is important to consider carefully the objectives with regard to the purpose of the study and the number of samples required to provide acceptable uncertainty in any conclusions.

### 4.1 Sampling in Emissions

A wide range of different methods are available for sampling the concentration of dioxins in ducts. These fall into three categories; the dilution sampler, the cooled probe method and the filter-condensor-adsorber method. It is the latter that is used by the great majority of UK stack sampling companies and will be discussed further below. A full description of sampling methods and requirements are given in European Standard EN 1948 : 1997 and the US Environmental Protection Agency Method 23. Within the European Union EN 1948 : 1997 must be followed for hazardous waste incinerators and may shortly be required for other waste incinerators.

There are certain requirements in emission sampling which should ensure a useful sample is taken. Firstly the sampling period has to be representative of the operation of the process. The timing of the sampling period and its duration are important. While this is straightforward with continuous processes such as waste incinerators, with batch processes, such as cremators, care is required. The duration should depend on both the process variability and the need to collect sufficient flue gas to enable the required detection limit to be achieved.

The next requirement is that the sample that enters the nozzle of the probe should be representative of the flue gas passing through the plane of the sampling port. The main requirements are that the sample be taken isokinetically so that the particle size distribution sampled reflects that at the point at which the nozzle is held, and further that an adequate number of sampling points within the plane are used to reduce the effects of differences in concentration across the duct. This requires a suitable sampling position and ports. This latter condition is surprisingly rarely met even on new plant.

The PCDD/Fs which enter the sampler through the nozzle must then be presented for analysis without passing straight through the sampler, being degraded or added to within the sampler or lost to the sampler walls. These aims are achieved by using a validated adsorber, ensuring the adsorber works within the flow and temperature regime for which it is validated; in particular with the XAD-2 normally used it should not be allowed to get above 25°C and the filter temperature should not exceed 125°C to avoid PCDD/F formation on the captured fly ash. With early sampling trains in the 80s this was a problem making some of the first emission measurements of dubious value and this can still be a problem where an in-stack filter is used, as variability in the flue temperature can cause problems with achieving the requirement.

The sampling train used within the UK typically draws the flue gas through a sharp nozzle and a heated probe to a filter heated to prevent condensation. This traps the particle phase PCDD/Fs. The vapour phase PCDD/Fs are captured by passing the flue gas through a water cooled condenser and then through an adsorber containing a resin, typically XAD-2, which retains the PCDD/Fs. The vapour pressure of dioxins at typical filter temperatures is such that dioxins on the filter will evaporate and be drawn on through the sampling train. The condensate from the flue gas is also collected. The flue gas is then led through a flow control device which ensures that the sample is collected isokinetically and that the gas volume is measured accurately. At the end of sampling, the surfaces which have been in contact with the sample are rinsed with solvent. A sample is then submitted for analysis containing the filter, the adsorbent, the condensate and the solvent rinsings.

An issue with PCDD/F emission sampling is whether the results are meaningful. The sampling must be carried out with great care. The taking of a blank sample is to be recommended particularly where concentrations are low. Results where some isomers have not been detected or are subject to interference should be reported using both the upper and lower estimates thus providing a toxic equivalence which represents the bounds of the likely result. The uncertainty of PCDD/F emission sampling is considerable. In the validation trials for EN 1948 the uncertainties at two waste incinerators were measured as  $0.04 \pm 0.06$  ng I-TEQ/m<sup>3</sup>,  $0.03 \pm 0.014$  ng I-TEQ/m<sup>3</sup>. The wide confidence interval has led many to be suspicious of the validity of results at low concentrations. As with uncertainty of this magnitude it is difficult to establish what is the true concentration when the emission limit may be 0.1 ng I-TEQ/m<sup>3</sup>. This has led to calls for further validation measurements to be made to widen the available dataset and perhaps narrow the uncertainty.

## 4.2 Air Sampling

Air is sampled as the main transport route for PCDD/Fs. Several measures of levels can be made. Most commonly the air concentration is measured, less frequently deposition rates are determined.

Air concentration measurements provide an instantaneous picture of environmental levels. Additionally the volume sampled can be adjusted to provide detectable levels over sampling times greater than 24 hours. Typically a sampler is used in which air is drawn through a filter and polyurethane foam plug combination. Sample volumes greater than 250 m<sup>3</sup> will normally lead to sufficient PCDD/F being present to detect most isomers. 2,3,7,8 TCDD is often not found as its concentration is very low. There is strong seasonal variation in concentrations; hence to achieve representative estimates of annual mean concentrations at least a 3 month period should be sampled, and preferably longer, else it becomes difficult to estimate the annual mean concentration with any certainty. This is of course unless the dynamics of the relationship between weather and sources are being investigated in which case short term sampling can illuminate some of the environmental processes.

## 4.3 Vegetation Sampling

Vegetation is a suitable environmental media acting as an accumulator of PCDD/Fs during the growing season. The measured concentration represents an integral of the atmospheric concentrations from the start of the growing season. It is principally of use in assessing spatial patterns where similar species can be used. Hence around an industrial plant in an agricultural area grass can often be sampled. Pine needles have been analysed in several studies where samples are taken over a large distance. In urban areas it is difficult to obtain sufficient suitable sample plots. The concentration in vegetation will depend not just on the concentration of dioxin deposited onto the leaf surface associated with particles and adsorbed into the waxy cuticle, but also on the available surface area of the plant. Hence temporal surveys can only be carried out at similar times of year; they assume that the same growth profile has been followed in a similar manner from year to year presenting a similar plant surface area to the atmosphere. This is rarely the case. It is also more difficult to obtain sufficient sample to detect the PCDD/Fs adequately.

## 4.4 Soil Sampling

Soil sampling is commonly used to assess spatial changes in concentration around industrial sites which have been operating for some time. Soil acts as an accumulator of PCDD/Fs and hence with the very slow degradation rates of PCDD/Fs in the environment can almost be regarded as representing inputs over the last few decades. In industrial areas the levels will be between 5 and 50 ng I-TEQ /kg dry soil. The typical deposition rate from a modern waste incinerator may be 0.005-0.5 ng/m<sup>2</sup>/year. Given that the top 5cm is typically sampled this leads to a change of up to 0.01 ng TEQ /kg / year. As the uncertainty in a single individual analysis is around 15% it can be seen that it will be many years before a noticeable change is seen in soil concentrations; in contrast around older plant where the emitted concentration may have been 200 ng I-TEQ / m<sup>3</sup> in

some cases rather than 0.1 ng I-TEQ/m<sup>3</sup> as is presently the regulatory limit, a distinct footprint was detectable. Soil is a relatively cost effective medium to sample representatively. It is also straightforward to obtain sufficient sample for analysis.

Soil acts as a long term accumulator for dioxins. They are sufficiently tightly bound to the soil particle that they do not travel far in the soil unless the soil is itself mechanically disturbed. However when looking for patterns of contamination arising from atmospheric deposition it is wise to be careful that the sampling site is suitable. For example past use of chlorinated pesticides on crops may have led to a local unrepresentative enhancement of dioxin concentrations. The tendency of dioxins to accumulate in pine needles leads to the soil in coniferous woodland to generally show significant increase in concentration against the surrounding pasture. Hence when drawing up a sampling programme it is best to consider carefully the locations from which samples are to be taken.

The sampling itself is very straightforward. A normal garden bulb planter can be used if augers and other professional tools are not available. The vegetation is cleared away from above the point of interest. The cores are then wrapped in a clean material such as aluminium foil and stored carefully. Sufficient cores are taken to obtain around 1 kg per location. The individual cores being taken on a representative grid, for example at the corners of a square etc.

The samples are then returned to the laboratory. The root matter is removed and any visible large stones and living creatures. The soil is then allowed to air dry until reasonably constant weight is achieved. The sample is then lightly ground and then passed through a 2mm sieve. This dried ground and sieved sample is then presented for analysis.

## 5. Dioxin Analysis

The purpose of dioxin analysis is to be able to quantify the dioxins of interest having separated them both from the other chemicals present in the sample and from each other.

### 5.1 Extraction

The first stage with environmental samples is to extract the large molecular weight organic compounds from the matrix in which they are presented to the analyst. In general with soil samples such as filters, resins, soils and vegetation this involves passing a suitable solvent through the matrix sufficient times to remove the great majority of the dioxins present. While techniques are constantly advancing the soxhlet apparatus is the most commonly used. The sample is placed in a pre-cleaned cellulose thimble inside a vessel into which toluene is condensed. Once the vessel is filled a syphon empties the toluene into a boiling flask which is heated to evaporate off the toluene. The cycle then continues for many cycles.

The dioxins and other compounds are dissolved out of the matrix and transferred into the boiling flask. The extraction period is typically 24 hours. Among the other methods which are in use are Accelerated Solvent Extraction ASE® and supercritical fluid extraction. These more modern techniques have advantages of speed of extraction and use of cleaner less hazardous solvents. However the investment required is considerably greater.

In the case of liquid samples such as solvent washings or rainwater the samples are typically filtered to remove any solid material and then repeatedly liquid liquid extracted using a suitable immiscible solvent.

The efficiency of the extraction process, together with other losses through the analytical process, is measured by the addition to the sample before processing of stable isotope labelled dioxins and furans (popularly called the extraction spike). These, it is hoped, will behave in the same manner as the dioxins and furans from the sample. Hence any lack of extraction or adsorption to glassware or chemicals used during sample clean-up is addressed.

### 5.2 Sample Clean-up

Dioxins are present at very low concentrations. In order to detect them adequately separation from other compounds of similar size and mass is necessary. Most methods in use do this by open column chromatographic clean-up using a combination of pre-treated silicas and a mix of elution solvents to separate the PCDD/Fs from as many other compounds as possible. In recent years the laboratories with larger sample throughput have put effort into automating this process; however this approach has not received widespread acceptance as a result of the set up and validation costs and the perceived inflexibility between sample types.

### 5.3 Sample Quantification

At present laboratories carrying out dioxin analysis exclusively use mass spectrometry as the detection technique. This is combined with gas chromatography as a final clean up stage. This separates the PCDD/Fs from each other and from other chlorinated organic compounds. The individual dioxin isomers elute from the gas chromatograph depending in order of increasing chlorination. The mass spectrometer is fixed to monitor the two principal masses from the PCDD/F of interest. The theoretical ratio between the two principal ions can be calculated from the abundance of <sup>35</sup>Cl and <sup>37</sup>Cl. The measured ratio together with the observed retention time are used to ensure that a PCDD/F is being quantified.

Clearly the greater resolution with which the mass spectrometer operates the greater the certainty of avoidance of false positives. Many laboratories now use high resolution mass spectrometry operating at resolving powers of 1:10000 or so. A further advantage of high resolution mass spectrometry over the quadrupole instruments formerly used is much higher sensitivity and hence lower detection limits or smaller sample sizes.

## 6. The Way Forward

Presently major developments in dioxin sampling and analysis are not taking place. Improvements are being made in column choice, clean-up method and so on; however the sampling and analysis approaches have not changed dramatically over the last 5 years. Increasing sensitivity enables the determination of PCDD/F concentrations in almost any environmental matrix. Measures are increasingly required to reduce uncertainty in the measurement

methods. Increased attention on PCDD/Fs and dioxin like PCBs is likely with the implications of the ten fold reduction in TDI becoming expressed in policy decisions both at a national and international level.

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**Table 1.** The Number of Dioxin Isomers for Each Level of Chlorination

Number of chlorine atoms	Congener group prefix	Abbreviation	No of PCDD isomers	No of PCDF isomers
1	Mono		2	4
2	Di		10	16
3	Tri		14	28
4	Tetra	TCDD/F	22	38
5	Penta	PeCDD/F	14	28
6	Hexa	HxCDD/F	10	16
7	Hepta	HpCDD/F	2	4
8	Octa	OCDD/F	1	1

**Table 2.** Comparison of World Health Organisation and International Toxic Equivalence Factors (\* are given to highlight the differences)

Chemical	I-TEF	WHO-TEF
<b>Dioxins</b>		
2378 T4CDD	1	1
12378 P5CDD	0.5	1*
123478 H6CDD	0.1	0.1
123678 H6CDD	0.1	0.1
123789 H6CDD	0.1	0.1
1234678 H7CDD	0.01	0.01
OCDD	0.001	0.0001*
<b>Furans</b>		
2378 T4CDF	0.1	0.1
12378 P5CDF	0.05	0.05
23478 P5CDF	0.5	0.5
123478 H6CDF	0.1	0.1
123678 H6CDF	0.1	0.1
123789 H6CDF	0.1	0.1
234678 H6CDF	0.1	0.1
1234678 H7CDF	0.01	0.01
1234789 H7CDF	0.01	0.01
OCDF	0.001	0.0001*

**Table 3.** WHO TEFs for Dioxin-like PCBs

Chemical	WHO-TEF
33'44'	0.0001
344'5	0.0001
33'44'5	0.1
33'44'55'	0.01
233'44'	0.0001
2344'5	0.0005
23'44'5	0.0001
2'344'5 PeCB	0.0001
233'44'5 HxCB	0.0005
233'44'5' HxCB	0.0005
23'44'55' HxCB	0.00001
233'44'55' HpCB	0.0001

Table 4. Source of Dioxins in 1990, 1995 and 1998 (kg I-TEQ / year)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1998%
Power Stations (coal and oil)	35	35	32	26	25	23	22	18	18	6%
Coal Combustion- Industrial <sup>1</sup>	10	11	13	11	10	9	7	5	4	1%
Coal Combustion- Domestic <sup>2</sup>	28	30	27	27	21	14	15	14	13	4%
Wood Combustion- Industrial	16	16	16	16	16	16	16	16	16	5%
Wood Combustion- Domestic	10	10	10	10	10	10	10	10	10	3%
Coke production	3	3	2	2	2	1	1	1	1	0%
Sinter plant	42	42	41	40	41	42	42	43	43	13%
Electric arc furnaces (iron & steel)	12	10	11	11	10	9	9	9	8	2%
Non-ferrous metal production	27	24	24	24	23	24	24	22	22	7%
Chemical industry <sup>3</sup>	12	13	13	14	14	14	14	14	14	4%
MSW incineration <sup>4</sup>	602	602	602	602	521	413	196	11	14	4%
Incineration- Chemical Waste	6	6	5	5	5	4	4	4	4	1%
Incineration- Clinical Waste	51	51	51	51	51	44	35	24	24	7%
Incineration- Sewage Sludge	5	4	4	4	3	3	3	3	3	1%
Road Transport – Petrol	28	25	23	20	18	16	14	11	10	3%
Road Transport – Diesel	0	0	0	0	0	0	1	1	1	0%
Accidental Fires and Open Agricultural Burning	121	112	99	64	64	64	64	64	64	20%
Other Sources	68	68	67	69	66	64	63	58	56	17%
Total	1078	1063	1040	997	900	771	538	328	325	100%

Taken from UK Emissions of Air Pollutants 1970-1998, J Goodwin et al National Atmospheric Emissions Inventory, August 2000.

<sup>1</sup> "Coal Combustion- Industrial" includes coke  
<sup>2</sup> "Coal Combustion- Domestic" includes Solid Smokeless Fuel  
<sup>3</sup> "Chemical Industry" includes fuel combustion  
<sup>4</sup> "MSW Incineration" includes incineration for power and as waste treatment

Table 5. Physical Properties of PCDD/Fs

Congener	Melting Point °C	Vapour Pressure (Pa) @ 25 °C	Water Solubility (g/m <sup>3</sup> ) @ 25 °C	Octanol-Water Partition Coefficient log K <sub>ow</sub>
dibenzo-p-dioxin	120-124.2	0.05-0.055	0.068-1.84	3.40-4.70
dibenzofuran	82-92	0.35-2.026	1-10.03	3.91-4.57
2,3,7,8 tetrachloro dibenzo-p-dioxin	305-325	9.33x10 <sup>-9</sup> – 1.33x10 <sup>-4</sup>	0.0000072 -0.000688	5.38-8.93
2,3,7,8 tetrachloro dibenzofuran	219-229	0.000002 – 0.0001228	0.000351- 0.000419	5.82-7.70
2,3,4,7,8 pentachloro dibenzofuran	196-196.5	3.5x10 <sup>-7</sup> – 2.17 x 10 <sup>-3</sup>	0.000236- 0.000515	6.92-7.82
1,2,3,4,7,8 hexa chlorodibenzo-p-dioxin	259-275	5.1x10 <sup>-9</sup> – 7.85x10 <sup>-6</sup>	4.42x10 <sup>-6</sup> – 4.4x10 <sup>-3</sup>	7.30-10.89
1,2,3,4,7,8 hexa chlorodibenzo furan	225.5-226.5	3.2x10 <sup>-8</sup> – 8.9x10 <sup>-8</sup>	8.25x10 <sup>-6</sup>	7.7
1,2,3,4,6,7,8 hepta chlorodibenzo –p-dioxin	264-265	7.5x10 <sup>-10</sup> – 1.93x10 <sup>-6</sup>	2x10 <sup>-6</sup> – 8.48x10 <sup>-4</sup>	7.92 – 11.98
1,2,3,4,6,7,8 hepta chlorodibenzofuran	236-237	4.70x10 <sup>-9</sup> – 2.24 x 10 <sup>-6</sup>	1.35x10 <sup>-6</sup> – 1.08x10 <sup>-5</sup>	7.9-9.25
Octachlorodibenzo –p-dioxin	318-332	1.1x10 <sup>-10</sup> – 2.4x10 <sup>-5</sup>	7.0x10 <sup>-8</sup> – 1.8x10 <sup>-4</sup>	7.53-13.08
Octachlorodibenzo furan	258-330	5x10 <sup>-10</sup> – 2.6x10 <sup>-7</sup>	4x10 <sup>-8</sup> – 1.54x10 <sup>-6</sup>	6.94-13.93

(data taken from Mackay et al Illustrated Handbook of Physical-Chemical Properties and Environmental Fate for Organic Chemicals, Volume II, Polynuclear Aromatic Hydrocarbons, Polychlorinated Dioxins and Dibenzofurans, Lewis 1992)

# EFFECT OF FUEL SULPHUR ON VEHICLE EMISSIONS

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*"Brown's Great Green Diesel Myth"; "Benefits Few But Worth Having"; and "Budget To Cut Emissions?" were just a few of the headlines following November's pre-budget statement on the reduction in duty for ultra low sulphur petrol and diesel (ULSP and ULSD)<sup>1</sup>. The articles beneath the headlines were no clearer as to whether or not these fuels reduce emissions significantly. To some extent this confusion reflects the disagreement between the main vested interests – the motor manufacturers and the oil industry – over the need for and benefits of these fuels.*

*This article has been written to clarify the effect of sulphur in petrol and diesel on emissions. It updates earlier work undertaken for the NSCA<sup>2</sup>, and is based on recent work undertaken for the Department of Environment, Transport and the Regions (DETR) and the Department of Trade and Industry (DTI)<sup>3</sup>.*

## 1. Sulphur Content of Petrol and Diesel

Sulphur occurs naturally in crude oil. The level of sulphur in petrol and diesel depends on the sulphur content of the crude oil feedstock, the refinery production processes and the extent to which sulphur is removed. Traditionally diesel contains more sulphur than petrol. In the UK, however, a combination of EU legislation and fiscal incentives has driven the sulphur content of diesel below that of petrol.

The Motor Fuel (Composition and Content) Regulations 1999<sup>4</sup> introduced into the UK new quality standards for petrol and diesel from the beginning of 2000, implementing EU Directive 98/70/EC. This Directive also requires further fuel quality improvements in the year 2005 and covers a number of different fuel parameters including the sulphur content.

The maximum permitted sulphur content of diesel in the EU has declined rapidly from 3000 parts per million (ppm) in 1989 to 350ppm in 2000. In 2005 it will decline further to a maximum of 50ppm. The sulphur content of unleaded petrol has been controlled since 1993 when a maximum of 500ppm was permitted. Currently the maximum permitted is 150ppm, and this will decline to 50ppm in 2005.

It is probable that the sulphur content of automotive fuels will decline still further. In May 2000 the European

Environment Commissioner launched a "Call for Evidence" on the appropriate level of sulphur in petrol and diesel. While the European Commission has yet to announce its intentions, it is thought likely that a sulphur limit of 10ppm will be introduced, although when is uncertain.

### 1.1 Petrol

It is difficult to know precisely the sulphur content of fuel sold in the UK<sup>5</sup>. It is thought that the typical sulphur content of petrol in the UK in the late 1990s was about 200 ppm<sup>6</sup>. This is likely to have fallen to around 130ppm as a result of the new standard. In Japan the typical sulphur content is 25ppm, in California 20ppm and in the rest of the US 270ppm. Petrol with a sulphur content similar to that found in Japan has been sold in the UK since March 1995 at a small number of Tesco superstores in London, although it has been promoted as low benzene petrol rather than low sulphur petrol.

In October 2000 the Government introduced a 1p/litre reduction in fuel duty for ULSP (50ppm maximum). Within weeks most of the major petrol retailers including Sainsbury's, BP, and Esso were selling it, although, according to The Times newspaper<sup>7</sup> they were not necessarily promoting the cleaner fuel to their customers. The 1p/litre has not been passed on to customers, reflecting its increased production and marketing costs. In the pre-budget statement the Chancellor announced a further 2p/litre reduction in duty for ULSP from March 2001, on condition that this fuel is made available nationwide.

### 1.2 Diesel

In most countries the sulphur content of diesel remains higher than for petrol. Prior to the introduction of the new fuel quality standard, diesel sold in the EU typically had a sulphur content of around 400 ppm. It is estimated that this has declined to around 300 ppm today, and will fall to around 40 ppm in 2005.

The lowest levels of sulphur in diesel worldwide are in those EU countries that provide a fiscal incentive for cleaner fuel. In the UK a duty differential of 1p/litre for ULSD compared to conventional diesel was introduced in August 1997, and

<sup>1</sup>From: the Daily Mail (17th November 2000); The Times (10th November 2000); and Air Quality Management (December 2000) respectively.

<sup>2</sup>Cleaner Air: the Role of Cleaner Fuels, Cleaner Fuels Forum, NSCA, February 1998, Brighton.

<sup>3</sup>Emissions Effects and Costs of Sulphur Free Petrol and Diesel, report by SENCO for DTI, June 2000, and Emissions Effects and Costs of Sulphur Free Petrol and Diesel: Review of Sulphur Indices, report by SENCO for DETR, November 2000.

<sup>4</sup>The Stationery Office, Motor Fuel (Composition and Content) Regulations 1999, Statutory Instrument No 1999/3107.

<sup>5</sup>It depends of the market share as well as the source of crude oil and the efficiency of processes at each refinery supplying the UK market.

<sup>6</sup>Cleaner Air: The Role of Cleaner Fuels, Cleaner Fuels Forum, NSCA, February 1998, Brighton.

<sup>7</sup>Oil firms pocket 1p tax cut on green fuel', The Times, 10th November 2000, London.

increased to 2p/litre in March 1998<sup>8</sup>. This had little impact on the market until it was announced that the incentive would be increased to 3p/litre in March 1999. In the run up to its introduction the UK diesel market went ULSD virtually overnight<sup>9</sup>. A survey of UK diesel early in 2000 found that the average sulphur content was 14 ppm<sup>10</sup>. This is one hundredth of the average level measured just five years previously, and one twenty fifth of the level two years previously<sup>11</sup>. All the samples in the 2000 survey were well below 50ppm.

The lower density in the March 1998 definition of ULSD was introduced to reduce PM emissions. The lower density means more fuel is required, which mitigates any savings in cost per litre. The Freight Transport Association, and others, lobbied DETR to increase the density of diesel, and it is probable that the additional 3p/litre reduction in duty announced in the pre-Budget statement was its response to these pressures as well as the fuel price protesters. As this fuel is already being used exclusively in the UK the additional fiscal incentive will not introduce any new environmental benefit. For this reason the benefits of ULSD are not explicitly discussed further in this article. However, as diesel and petrol technologies become more similar, many of the points below, e.g. on DeNOx catalysts are applicable to both fuels.

In the past the excise duty on diesel has been greater than petrol in recognition of its greater contribution to emissions of NO<sub>x</sub> and PM. From March 2001 the level of duty on both fuels will be 45.82 p/litre.

## 2. Effect of Sulphur on Vehicle Emissions

Reducing the sulphur in fuel has three principal environmental benefits:

- It reduces emissions from existing catalyst-equipped vehicles, particularly from the latest generation of petrol vehicles. A car meeting current emission limits (Euro III) running on ultra low sulphur petrol (30 ppm sulphur) will have about 40% lower NO<sub>x</sub> emissions than the same car running on standard petrol (130 ppm sulphur).
- It enables new catalyst technology to be introduced onto the market. This is important for the introduction of more fuel-efficient cars, to reduce carbon dioxide (CO<sub>2</sub>) emissions from road transport, and to reduce particle emissions from diesel vehicles.
- In addition, recent evidence on the formation of ultra fine particles suggests that an important precursor of nanoparticles (less than 50 nanometers in diameter) in vehicle exhaust is sulphur dioxide. Reducing sulphur from fuels (and lubricants) could reduce this vehicular source of extremely small particles.

<sup>8</sup>Restrictions on the density and T<sub>90</sub> (the temperature at which 95% of the fuel evaporates) were also introduced at this time.

<sup>9</sup>All change! Standard diesel dropped by UK as majors announce phase-out within weeks', Hart's European Fuels News, Volume 3, Issue 3, 10th February 1999.

<sup>10</sup>Survey undertaken by Renault and reported in Review of the Impact of Fuel Sulphur on Advanced Aftertreatment Systems, Mike J Hawkins and Gary P Smith, Ford Motor Company, February 2000.

<sup>11</sup>Winter Diesel Fuel Quality Survey, Paramins, 1995 and 1998. Samples collected over the period December 1994-February 1995, and January and February 1998 respectively. In 1995 the average sulphur level was 1410 ppm and in 1998 350 ppm.

Controls on the sulphur level of fuels have not been introduced to control emissions of sulphur dioxide, as road transport contributed only a few percent of national sulphur dioxide emissions.

### 2.1 Current Technology

All the major studies undertaken in Europe, Japan and the US over the last decade have shown that reducing the sulphur content of the fuel improves the performance of catalysts, reducing exhaust emissions of HC, CO and NO<sub>x</sub>.

The response of catalysts to fuel sulphur is initially linear, when the catalyst is new. That is, emissions increase in direct proportion to the sulphur in the fuel. However, as the catalyst ages the effect becomes non linear, and the incremental effect is greatest at low fuel sulphur levels<sup>12</sup>. At extremely low levels of fuel sulphur, i.e. below about 30 ppm, there is some evidence that the sulphur in the lubricants may be affecting catalyst performance<sup>13</sup>.

Vehicle test programmes may underestimate the impact of sulphur on emissions during real-world urban driving conditions because lower exhaust temperatures are reached than during test cycles, thus reducing the potential of removing sulphur from the catalyst.

As emission standards have tightened and catalyst efficiency improved, the technology has become more sensitive to the effect of fuel sulphur. The US Environmental Protection Agency estimates that NO<sub>x</sub> emissions from Californian low/ultra low emission vehicles are roughly 10 times more sensitive to the sulphur in the fuel than the US Federal Tier 0/Tier 1 vehicles<sup>14</sup>.

The only major study of the effect of sulphur on European catalyst cars was the European Programme on Emissions, Fuels and Engine Technologies (EPEFE), undertaken in the mid 1990s<sup>15</sup>. Results from this programme suggest that reducing sulphur from 130ppm to 30ppm would reduce NO<sub>x</sub> emissions by only 2%. However, the cars in this programme were only aged for 8,000 km and few utilised the advanced technology seen on new cars today. Extrapolating from more recent US studies suggests that for cars meeting the current EU emission standards the benefits might be as great as a 40% reduction<sup>16</sup>. The potential benefits of introducing sulphur free fuels (i.e. with less than 10ppm sulphur) is illustrated by the effect of reducing the sulphur from 40ppm down to 8ppm. We estimate that this will reduce NO<sub>x</sub> emissions by 20%. The impact on CO and HC emissions is smaller.

Relatively few studies have been undertaken to investigate the impact of sulphur on the performance of diesel oxidation catalysts. These catalysts are fitted to most modern diesel cars, primarily to reduce emissions of

<sup>12</sup>Coordinating Research Council, 1997, 'Sulfur/LEV Program.

<sup>13</sup>Personal Communication, Bob Gorse, Ford Motor Company.

<sup>14</sup>Appendix B: Evidence Supporting the Irreversibility of Sulfur's Emission Impact, Regulatory Impact Analysis, US Environmental Protection Agency, December 1999, <http://www.epa.gov/oms/regs/ld-hwy/tier-2/frm/ria/app-b.pdf>

<sup>15</sup>European Programme on Emissions, Fuels and Engine Technology, ACEA/EUROPIA, undated, Brussels.

<sup>16</sup>Emissions Effects and Costs of Sulphur Free Petrol and Diesel: Review of Sulphur Indices, report by SENCO for DETR, November 2000.

particles, but they also reduce CO and HC emissions. Under certain operating conditions these catalysts can increase particle emissions above engine-out emissions due to formation of sulphate particles from the fuel sulphur across the catalyst. The magnitude of this increase is directly proportional to the amount of sulphur in the fuel. Fuel sulphur also affects the removal of CO and HC by oxidation catalysts<sup>17</sup>.

Particulate traps can remove over 90% by weight of the exhaust particulate matter. This technology is on the market with many thousands currently in use in Europe, particularly on urban buses. Independent studies of the performance of traps show that the technology is effective, with over 95% removal of particles, using sulphur free fuel (3ppm), compared to 73% removal with ULSD (30ppm)<sup>18</sup>.

## 2.2 Future Technology

The car manufacturers' associations representing the industry in Europe<sup>19</sup> have agreed to reduce new car CO<sub>2</sub> emissions by approximately 25% over the period 1996 to 2008. This voluntary agreement is putting renewed emphasis on the fuel consumption of passenger cars, and other vehicles. Unlike emissions of the regulated pollutants<sup>20</sup>, control of CO<sub>2</sub> cannot be achieved through the use of an after-treatment device. Instead, there have to be efficiency improvements to the vehicle. There are a number of ways in which this can be achieved, but in practice the motor industry believe that the focus will be primarily by improving the power-train system. In particular, new lean-burn engines will be used, such as the Mitsubishi gasoline direct injection (GDi) engine, which was launched on the European market in October 1997.

Whilst lean burn engines offer fuel economy and hence CO<sub>2</sub> benefits they emit higher levels of nitrogen oxides (NO<sub>x</sub>) compared to conventional petrol vehicles fitted with a three-way catalyst. To reduce NO<sub>x</sub> emissions to levels compatible with European emission standards requires the use of new types of emission control technology.

The available evidence suggests that the technology that is most efficient at removing NO<sub>x</sub> emissions is extremely sensitive to the presence of sulphur in the fuel. Other technologies that are less sensitive to sulphur have lower NO<sub>x</sub> removal capabilities. Strategies to reduce the sulphur impact increase the fuel consumption of the vehicle, counteracting the purpose of using lean burn technologies.

Selective catalytic reduction (SRC) can continuously remove NO<sub>x</sub> from direct injection gasoline and diesel engines. Several different systems are under development, using different reducing agents. The most efficient use ammonia, produced on-board from urea. These systems may remove 60-80% of NO<sub>x</sub> emissions from heavy-duty vehicles. The urea has to be carried on the vehicle and added to the exhaust

gases using a sophisticated dosing and monitoring system. The large volume of urea required will probably make this system unviable for light duty vehicles. Systems using other reactants (e.g. hydrocarbons) are only 15-30% efficient at removing NO<sub>x</sub><sup>21</sup>.

Nitrogen oxide adsorbers, also known as NO<sub>x</sub> storage reduction catalysts, store the NO<sub>x</sub> on the adsorber during lean operation. When it needs regenerating the engine management system changes to rich conditions, releasing the stored NO<sub>x</sub>, which is then removed with a three-way catalyst. Optimising the duration and 'richness' of the rich phase is crucial to minimising emissions and fuel consumption. Prototype systems have demonstrated up to 90% removal of NO<sub>x</sub>. However, these systems are very sensitive to fuel sulphur which forms sulphates on the absorber. This can be removed but requires higher temperatures and richer conditions than those needed to remove nitrates. Thus the engine needs to run rich more often removing some of the fuel economy benefits of lean combustion<sup>22</sup>.

## 2.3 CO<sub>2</sub> Benefit and Costs

The production of sulphur free fuels requires additional energy at the refinery, and therefore involves an increase in CO<sub>2</sub> emissions. If these fuels are introduced to enable more fuel-efficient vehicles to be introduced onto the market, it is important that there is a net reduction in CO<sub>2</sub> emissions. Whilst there remain uncertainties as to the real fuel economy benefits of sulphur free petrol and the additional refinery emissions from producing it, it appears likely that at least 50% of the vehicles will have to use DeNO<sub>x</sub> after-treatment for there to be a net CO<sub>2</sub> benefit<sup>23</sup>. This is unlikely to be the case for several years. In the short term, therefore, there is likely to be a small net CO<sub>2</sub> penalty of producing these fuels.

The cost of producing these fuels is small. According to the evidence submitted to the European Commission in response to their call for evidence the additional cost of producing sulphur free petrol (compared to ULSP) in the EU varies from less than a 0.1p/litre up to about 0.2p/litre. The additional cost of producing sulphur free diesel varies from 0.1 to 0.4p/litre (except in Ireland where it is estimated to cost about 2p/litre). The additional cost for UK refineries has been estimated by the UK Petroleum Industry Association to be less than 0.2p/litre for both petrol and diesel<sup>22</sup>.

## 3. Summary

SENCO's analysis of US studies suggests that the introduction of ULSP could reduce NO<sub>x</sub> emissions from the most advanced vehicles by up to about 40%, whilst the benefit for older technology vehicles is likely to be smaller. As advanced vehicles only represent a relatively small

<sup>17</sup> Diesel Emission Control Sulfur Effects Program, Phase 1 Interim Data Report No 3: Diesel Fuel Sulfur Effects on Particulate Matter Emissions, DECSE, November 1999.

<sup>18</sup> Diesel Emission Control Sulfur Effects Program, Phase 1 Data Report No 4: Diesel Particulate Filters, DECSE, January 2000.

<sup>19</sup> ACEA - European Automobile Manufacturers Association, JAMA - Japanese Automobile Manufacturers Association and KAMA - Korean Automobile Manufacturers Association.

<sup>20</sup> Carbon monoxide, nitrogen oxides, hydrocarbons, and for diesel vehicles, particulate matter.

<sup>21</sup> Emissions Effects and Costs of Sulphur Free Petrol and Diesel, report by SENCO for DTI, June 2000.

<sup>22</sup> Emissions Effects and Costs of Sulphur Free Petrol and Diesel, report by SENCO for DTI, June 2000.

<sup>23</sup> Consultation on the Need to Reduce the Sulphur Content of Petrol and Diesel Fuels Below 50ppm - A Policy Makers' Summary, A report produced for the European Commission, AEA Technology, November 2000. <http://europa.eu.int/comm/environment/sulphur/summary.pdf>

fraction of the total number of cars on the UK roads, the overall benefit of using ULSP would be to reduce car NO<sub>x</sub> emissions by about 5% in 2001 rising to around 15% in 2004.

It is likely that sulphur free petrol will be introduced in the future. Assuming this occurs around 2008, when the vast majority of cars on the UK road will have advanced technology catalysts, we estimate that this may result in a further 15% or so reduction in NO<sub>x</sub> emissions.

The extra cost of producing sulphur free fuels is likely to be low, much less than one penny per litre. There is, however, likely to be a small CO<sub>2</sub> penalty in the short term.

## Acknowledgements

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# Powerful Emissions

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*The pressure to reduce polluting emissions to atmosphere from our daily activities has never been greater, and this pressure is increasing from a number of directions. Nowhere is it felt more keenly than in the "traditional" power generation industries, particularly power from coal. The transport sector may be the current "bad guy" of choice for action on air quality but transport does not have to deal with the number of pollutants or range of issues faced by the power sector. It is perhaps a testament to the rigorous - or esoteric, depending on your view-point - pollution control regimes developed in the last ten years in the UK, that emissions from power stations are not more in the news. The existence of Integrated Pollution Control (IPC), set up under the Environmental Protection Act 1990, has offered a solution to the majority of emission problems which have come to light from power stations. It has also been said that the complexities of the authorisation process have blocked a wider public understanding of industrial emissions but this has to be set against genuine improvements in the emissions from UK power generation. However, IPC was not set up to deal with the one environmental issue which is emerging as being paramount for the energy generation and supply industries, that of climate change.*

## Climate Change

Power generation is the largest source of anthropogenic carbon dioxide, the main "greenhouse gas", in the UK. Climate change is increasingly becoming the primary driver for all emissions reduction policies, and rightly so as the potential consequences of global climate change outweigh the consequences of all other major atmospheric pollutants. However, power generators are not required to monitor their emissions of CO<sub>2</sub>, and nor are emission limits set under the IPC authorisations issued by the Environment Agency. The only regulatory control here is the general requirement under BATNEEC that operators run their processes as efficiently as possible. As this means that the operator squeezes more power out of each unit of fuel, the Agency is pushing against an open door.

The Environment Agency will have some influence under the IPPC regime, as this requires operators to consider energy efficiency and to improve it where possible. IPPC extends beyond the power sector and so this requirement will have the effect of reducing demand and, potentially therefore, CO<sub>2</sub> emissions. The ultimate responsibility for reducing UK climate change gas emissions rests with the Government and

is only likely to come about through radical reforms to the structure of the energy market and the sort of incentives which the much tinkered with, and increasingly ill-fated, Climate Change Levy was originally intended to provide.

## Sulphur Dioxide, Oxides of Nitrogen and Particulate

The other priority pollutants, namely sulphur dioxide, oxides of nitrogen and particulate, are important both in long range transport (e.g. acid rain) and local air quality. Approximately 33% of UK SO<sub>2</sub> emission are deposited on the UK, in either dry or wet deposition processes, and up to 35% of SO<sub>2</sub> deposited in the UK is of continental European origin. Deposition occurs mainly in upland, high rainfall areas such as Wales and the Pennines. In terms of particulate, emission after control is mainly PM<sub>10</sub>, although in relation to vehicle emissions the power sector's contribution is relatively low. The main contribution made to the UK particle load by power generation (in this case coal and oil fire generation) is in terms of secondary particles – solid oxides of sulphate and nitrate form in the atmosphere. These particles are generally in the ultra-fine size range and are therefore of great concern in terms of health effects.

It is perhaps ironic that the most recent projections of climate change have increased the scale of expected warming, largely as a result of the reduction in sulphur emissions. Previous projections by the International Panel on Climate Change (IPCC) suggested an increase in the average global temperature of 2°C. However, this took into account a certain degree of "sulphate cooling", the effect brought about by the reflection of the sun's energy by sulphate particles in the upper atmosphere. Following concerted action by European and North American Governments, the level of sulphate in the atmosphere has decreased, reducing the influence of sulphate cooling. The IPCC's latest projection now puts the likely global temperature rise at 3°C, within a confidence range of 1.5-6°C.

These pollutants do have emission limits and are controlled under IPC, and the authorisation arrangements brought in by the Agency in 2000 attempt to deal with both of these environmental issues. While stack emission monitoring and dispersion modelling are important, validation using ambient monitoring is necessary in order to have confidence in the results modelling produced. Continuous on-line ambient monitoring, for SO<sub>2</sub>, NO<sub>x</sub> and particulate

(as PM<sub>10</sub>), is carried out by a large number of local authorities and through a national network of sites operated by the Department of the Environment, Transport and the Regions (DETR).

The main drawback is that these sites are not usually in locations best suited to the monitoring of emissions from particular power stations. Up until recently, this need has been filled by ambient monitoring stations run by the station operators themselves, under the Joint Environment Programme (JEP) agreed with the Agency. These stations provide data to the operators, the Agency and local authorities, allowing better management of the processes, greater confidence in the model predictions and base information to feed into local air quality reviews. The agreement has somewhat broken down in the Aire Valley, where new operators not originally signed up to JEP have not seen the need for the stations and closed them down. It is hoped that this issue will be resolved within the Management Plans required by the Agency under revised authorisations, and which were submitted in June last year.

### Delivering Emission Reductions

The abatement options for all of these pollutants run along broadly similar lines, although those lower in the hierarchy tend to deliver less by way of CO<sub>2</sub> reduction. The first option must be to reduce emissions by changing to low or zero emission technologies, such as wind, wave or solar power. Some would add nuclear power to this list but the failure to find a long term, sustainable solution to radioactive waste disposal does tend to take it out of contention. This is potentially a long term process and will require a restructuring of our electricity supply market. Shorter term benefits could be derived from efficiency improvements in generation, along with demand management and it is here that CHP fits into the picture.

The immediate future for the renewables sector as a whole remains mixed. Last year saw the commissioning of the UK's first commercial wave power station, at Islay, and the first off-shore wind farm, off the Northumbrian coast. Both of these technologies have been offered as long term solutions to the UK power demand problem as have a number of other promising areas. This is also one area where the major environmental pressure groups, such as Friends of the Earth and Greenpeace, are on the same side of the table as big

business, both apparently keen to see renewable technology develop, supported and implemented on a wide scale. The blocks appear in the form of complex funding arrangements, even more complex planning processes and a supply industry structured to favour large, existing, centralised generation. Even CHP is facing problems with up to one third of schemes which have planning permission unlikely to go ahead, with the CHP Association citing market conditions as the main difficulty.

Another obvious emission saving could be made by changing the fuel used in generation, e.g. by switching to gas or using only low sulphur coal. However, this has major implications beyond simply the environmental concerns which sustainable development demands be taken into account. Not least among these is the devastating impact on the many communities still reliant on coal mining in this country, particularly as low sulphur coal is almost exclusively imported.

While there are some not insignificant savings to be made through altering operational practices to concentrate on avoiding peak pollutant concentrations, the remaining options are the familiar emission treatment technologies. The most efficient of these in terms of SO<sub>2</sub> reduction is FGD but there are strong arguments against its wider use on sustainability grounds. The huge amount of virgin limestone required and the additional vehicle movements it creates illustrates the shifting of an environmental problem to other media, something which both IPC and IPPC are implicitly set up to avoid.

There is no doubt that further reductions in the emissions of CO<sub>2</sub>, SO<sub>2</sub>, NO<sub>x</sub> and PM<sub>10</sub> from the UK will be required by international conventions, EU Directives and UK law. We have come to a point where these reductions will require both radical solutions and difficult decisions. It is up to national policy makers to meet this challenge and develop solutions which can benefit us all.

*A version of this article first appeared in the journal UK Power 2000, issue 4.*

Tim Williamson, Policy Officer, NSCA  
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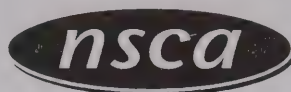
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# Editorial

## DIG THE NEW BREED

Hands up if you've heard of Urban Environmental Management. Community wardens, perhaps? Economic, social and environmental well-being? If your hand is not firmly raised in the air by now, it soon will be, unless you happen to be living on Mars. In this issue we focus on some of the work currently underway, much of which has been pushed forward by NSCA's Local Environment Management Forum, to find solutions to the problems of degraded urban environments and the application of sustainable development in the real world. In this case, the word urban takes its widest definition, extending from the large cities, through towns, down to the village level in some areas.

Urban environmental management, the control of anti-social behaviour and the raising of the quality of our urban areas are all fast ascending the political agenda, as shown by the Prime Minister's speech on 24 April and the continuing development of the community/neighbourhood warden concept. Nick Easton, Head of Policy for the Local Government Association sets the national policy scene by looking at the new Community Strategies all local authorities are required to produce, and the "well-being power" now available to help implement them. Helmut Lusser, Director of Global to Local Ltd. focuses on environmental management systems and their application in local authorities, drawing out some of the advantages, and stumbling blocks, of setting such systems in place.

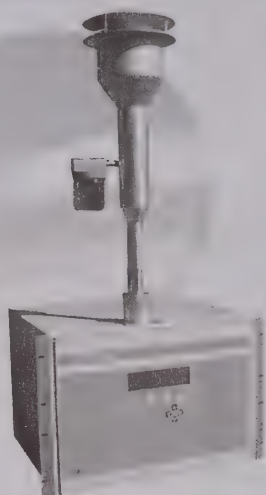
The remainder of the issue is given over to an exploration of what can be done to improve the local environment, given the motivation, creative thinking, political support and resources. We bring together the experiences of three local authorities in running community warden schemes, introduced by Susan King, Head of the Neighbourhood Wardens Unit, whose £50m budget to support these schemes has just been trebled. Robin Mager, from Telford and Wrekin Council provides an example of community participation in practice.

We also feature two of the winners and two runners up in our Innovations In Sustainable Development Awards. East Sussex County Council's Weald WoodNet took first prize in the "Progressing Sustainability Through Partnerships" category, while Leicester City Council won the "Managing the Impact of Local Authorities" category with their Eco-Management and Audit Scheme. From among the highly commended entries we feature Bolton MBC's Environmental Strategy 2000-2005: Greening the Council and Blyth Valley's Cramlington Organisation for Nature and the Environment.

Finally, we have an obituary for Allan Brown, who died on 8 February 2001. Allan was a prominent member of NSCA Council, the Local Environment Management Forum and the Air Quality Committee, and his active support of the East Midlands Division will be sorely missed.

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# Environmental Management

## Community Leadership and Part 1 of the Local Government Act 2000

Nick Easton

Local Government Association

*Part 1 of the Local Government Act 2000 provides for the first time a clear statutory basis for councils' role in community leadership.*

*Many of the issues facing local communities today – health, community safety, the environment, social inclusion, unemployment, regeneration – can only be tackled effectively if the wide variety of public, private and voluntary sector organisations involved at local level work together. No single organisation acting alone has the complete answer – but working together gives us the best chance to maximise our combined effort, avoid duplication and make the greatest impact.*

Communities need to know that all the key organisations in their area are working together in the pursuit of well-being. Councils, because of their democratic legitimacy and breadth of statutory roles and responsibilities, are best placed to co-ordinate this process. In the increasingly complex world of local governance effective leadership by councils is more important than ever.

At its simplest community leadership involves councils working in partnership with local people and organisations to develop a shared vision for the future of their locality, identifying immediate priorities for action, and then working together to deliver change. It is about “making a difference” in our localities and developing effective processes for doing it.

Whilst community leadership has always been part of what local authorities do the Local Government Act 2000 has now for the first time established this role in law. In particular it:

- requires councils to develop a strategy (or vision) for their community – with local people and partner organisations, and
- gives councils a new power “to do anything” to promote the well-being of the communities they represent. It also
- means that councils must work with key local partners through a Local Strategic Partnership (LSP).

Taken together these three elements provide a new framework designed to support effective community leadership. This article looks at each in turn.

### Community Strategies

An integral feature of effective leadership, in any context, is strategic vision.

Section 4 of the LGA 2000 requires councils to prepare a strategy (a community strategy) for promoting or improving the economic, social and environmental well-being of their area and contributing to sustainable development in the United Kingdom. In doing so councils must consult and seek the participation of such persons as they consider appropriate.

But what is a community strategy - and what does it look like?

The community strategy is meant to be a shared statement of the priorities facing the area and the actions that need to be taken towards pursuing the well-being of the area and contributing to sustainable development in the UK. It is not a council document but is intended to be one owned by local people and organisations and implemented by the council and its local partners.

Whilst community strategies will differ from place to place experience demonstrates that if they are to provide strategic direction and a framework for action each strategy is likely to contain a relatively small number of major themes or priorities along with some more specific measurable targets.

But it would be wrong for councils to think that they can prepare and implement such a strategy alone. The **process** of working with local communities and local partner organisations to:

- identify local needs/priorities
- think for the long term
- identify short term objectives
- analyse resources
- initiate action
- review progress

is equally important. Indeed, it is the quality of the process and the success of its outcomes rather than the strategy document itself that will deliver for local people. We need to avoid the possibility that the strategy is seen as the only product of the process - it clearly is not.

Community planning, the process of preparing and implementing community strategies, will not be easy. There are a number of inherent tensions within it and it throws up a number of challenges for councils and their local partners.

**Starting:** Councils need to avoid the temptation to initiate a whole new set of implementation arrangements. Rather they should start from where they are and build on what they already know about community priorities and on the partnerships that are already in place locally.

**Effective consultation:** Councils will need to think carefully about how to fulfil their statutory duty to consult and involve people and organisations in the process. Whilst this is one area where councils will be able to build on their existing knowledge, how are they to resolve the tension between seeking to allow as many people as possible to contribute whilst at the same time trying to secure more qualitative information that will help shape relative priorities? And what about those traditionally “hard to reach” groups?

**Effective partnerships:** Effective partnership working is at the heart of community planning – but how can councils seek to secure maximum “buy in” to the strategy from as many local partners as possible and at the same time work with their key partners to implement the strategy? Whilst there will already be some local structures in place and councils have a lot of partnership experience to build on, that experience tends to suggest that it will be easier to agree the vision than bend partner resources to secure successful implementation.

**What community?** For many councils it is not automatically clear what geographic area the community strategy should encompass. Whilst at first sight it might be sensible to base the strategy on the local authority’s area there is no requirement to do so – and many councils are developing community strategies at locality or neighbourhood level. They argue that local people more readily identify with their locality; that it’s easier to involve people at the local level; that it’s at the local level that the integration of plans and agencies’ activities really needs to be brought together and that there is a logical fit with the development of devolved decision making arrangements as part of their new political management arrangements.

**In two/three tier areas:** How does community planning play out in two tier areas where both county and district councils have a statutory responsibility to prepare a community strategy? The logic is that it should take place on a partnership basis and that either complementary strategies are produced at a county and district level or (preferably?) joint strategies are produced.

**Relationship to other plans:** If councils are being urged to build on where they are then for many the first issue to be resolved will be the relationship between community strategies and other plans – in particular LA21.

How to do this will depend on local circumstances. In many areas where there is a well established medium for taking forward what is predominantly an environmental strategy then this would probably best sit as a plan within an overarching community strategy. In other cases a

comprehensive LA21 strategy encompassing economic, social and environmental well-being might effectively become the community strategy. Whatever approach is adopted it should be remembered that community strategies are intended to contribute towards sustainable development in the UK. Councils would be wise to consider how they can use the experience of their LA21 co-ordinators in this process.

Similar sets of relational issues arise with Health Improvement Programmes and the LGA’s New Commitment to Regeneration.

A second key issue will be the relationship between the community strategy and other plans. Councils currently produce a plethora of statutory and non statutory plans – but what is it that unites them? What are their combined outcomes likely to be? This plethora of plans leads in turn to a plethora of activity. How can we use the community planning process to link these plans together to ensure that they reinforce or “add value” to one another, rather than duplicate or contradict? Can councils create a framework that seeks to “nest” plans underneath the community strategy “umbrella” and to co-ordinate the activities that flow from them in a more effective way.

All these issues are explored in more detail in “Preparing Community Strategies: Issues and Advice” LGA, December 2000, available on the LGA website.

## New Power to Promote Well-being

The duty to prepare community strategies is linked to the new power for councils “to do anything” to promote the economic and/or social and/or environmental well-being of their area, also contained in Part 1 of the Local Government Act 2000.

Indeed the new power provides one of the key means by which councils and their local partners can work together to pursue the community strategy priorities and the well-being of their communities.

The power is significant for two reasons. First it provides a new general power to act – a power of first resort. Secondly it is specifically intended to support more effective partnership working at the local level.

**A power of first resort.** Since the 19th century local government has been constrained by the doctrine of *ultra vires* – councils can only do that which is permitted by powers conferred by Parliament in statute. The *ultra vires* doctrine imposed a negative control over councils and did nothing to encourage innovation, enterprise and the development of a positive proactive role for local government.

Put simply Part 1 of the LGA 2000 reverses this position. It gives councils a new general power to act – *a power of first resort*. Councils no longer need to ask “Do we have the power to do this?” Now the question is “Does what we want to do support well-being?” If so, “Is there anything to prevent us from doing it?” Provided what a council wants to

do is likely to contribute towards well-being and is not expressly prohibited, then it can act.

Not only has the presumption changed – but the legal framework in Part 1 has been deliberately drafted in a way to maximise councils' freedom rather than to constrain it. Section 2 provides councils with:

- a power “to do *anything*”
- which “ *they* consider is *likely* to achieve”
- the economic *and/or* social *and/or* environmental well-being of their area.

Moreover the power can be exercised for the benefit of:

- the whole or part of the area
- all or any persons resident
- and even for the benefit of any person or area situated outside their area.

It is difficult to conceive of how the power could have been drafted more widely or flexibly.

Of course there are some limitations. Section 3 indicates that councils can't:

- use the new power to do anything which statute prevents, restricts or limits them from doing;
- use the power to raise money.

But even here there is some hope. Section 5 of the 2000 Act gives the Secretary of State power to remove legislative barriers to well-being and the Government has said it intends to make regulations under Section 150 of the Local Government and Housing Act 1989 to provide councils with power to charge for certain discretionary services, including those provided by virtue of the well-being power.

Lastly councils must have regard to the community strategy when determining whether or how to exercise the new power. Community strategies are expected to take an integrated approach to the economic, social and environmental well-being of the area and thereby contribute to sustainable development in the UK.

**Supporting partnerships:** The new power is also intended to support innovation and closer joint working between councils and their local partners to improve communities' quality of life.

Section 2 builds on the provisions in the Health Act 1999 which provide health authorities and councils with power to work together – but extends the council's ability to work in partnership with other bodies. Section 2(4) of the Act exemplifies the kind of action that the new power supports – it includes incurring expenditure, providing staff, goods or services to any person, entering into partnership arrangements and carrying out the functions of other bodies.

The new power provides the means to help meet local priorities emerging through the community planning process and provides the legislative backing to facilitate more effective partnership working between organisations.

The challenge for councils over the next few years will be to demonstrate how use of the new power has made a

practical difference in their community. It will not be easy. The new power opens up new opportunities – but these will not be realised without a new perspective. Councils need to think beyond their range of existing statutory services, for which powers already exist, to their wider responsibility for the well-being of the area as a whole. New thinking will be required and as a first step all councils need to:

- initiate an awareness raising programme amongst members, officers and partner organisations about the new power, what it does and does not allow councils to do;
- ensure that the use of the new power is seen as an integral part of the community planning process and as a means of meeting the priorities set out in the community strategy;
- consider how the new power can support the role of the Executive, individual Cabinet members, Overview and Scrutiny Committees and the role of non-Executive members.

The LGA has prepared a '*Powerpack*' to help councils begin the process of thinking through for themselves how they might be able to use the new power for the benefit of their communities. '*Powerpack: using the new power to promote well-being*', LGA, December 2000 is available on the LGA's website.

## Local Strategic Partnerships

Many of the councils that pioneered the early approach to community strategies found that the best way of securing the on-going commitment and involvement of key local partner organisations is through the establishment of an overarching strategic partnership – a local strategic partnership.

This concept has come together from a number of separate places – in the context of community strategies; through the LGA's New Commitment to Regeneration; through Local Public Service Agreements and in the context of the National Strategy for Neighbourhood Renewal Action Plan published in January 2001.

DETR has now published non statutory guidance on LSPs. It describes LSPs as a single body that:

- brings together at a local level the different parts of the public sector as well as the private, business, community and voluntary sectors so that different initiatives, programmes and services support each other and work together;
- is a non-statutory, non-executive organisation;
- operates at a level which enables strategic decisions to be taken and is close enough to individual neighbourhoods to allow actions to be determined at community level; and
- should be aligned with local authority boundaries.

It sets out their core tasks as being:

- preparation and implementation of community strategies;
- providing a forum for the co-ordination of plans, partnerships and activities;

- working with councils developing a local public service agreement;
- developing and delivering a local neighbourhood renewal strategy.

It will be for councils to initiate the development of LSPs where they don't already exist - but once established members of the LSP itself are expected to decide who should take the lead.

Developing effective LSPs will hold a number of challenges for councils:

- balancing their leadership responsibilities with the need to work through partnership. The LSP is meant to be a partnership of equals;
- making LSPs work effectively - moving beyond the development of a broad community strategy to real joint working;
- and in the longer term realising the opportunities LSPs provide to rationalise other partnerships and plan making processes.

## Conclusion

Community strategies, the new power and LSPs represent the key elements of the new package to support councils' role in community leadership. Each has its own set of opportunities and challenges. But community leadership itself is bigger than all three - and councils must avoid the temptation to focus on these three mechanisms at the expense of the wider gain.

Making a success of community leadership is essential if Ministers (of whatever party) with a mandate to deliver tangible improvements in areas such as education, health and the environment are to opt for locally tailored approaches rather than more prescriptive national solutions.

Effective community leadership will not be easy but as John Stewart says

"The new role of community leadership, the new duty to prepare community strategies and the new powers of community well-being challenge local authorities to realise the new opportunities. Nothing would be worse for local authorities than to fail to realise those opportunities and thus fail to show the potential of local government. If however local authorities respond to these opportunities they will have gone far to build a concept of local government as communities governing themselves, confronting and meeting issues raised locally and realising local aspirations".

Community leadership and the challenges it provides are discussed more fully in "Community leadership: what is it?" LGA, March 2001 - available on the LGA's website.

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# Improving Environmental Performance

## Environmental Management Systems in the Public Sector

Helmut Lusser

Global to Local Ltd

*Standards for environmental management systems (EMS) have been with us for almost a decade. The phrase - and even more the usually lengthy explanation of what an EMS is - can be the ultimate conversation killer. Yet the systems were seen by their authors as something rather exciting. They were to be designed to have a strong role in helping to bring about a higher degree of environmental sustainability. In the latest EU Environmental Action Programme **Environment 2010 - Our Future, Our Choice** the European Eco-management and Audit Scheme (EMAS) is highlighted as one of the few key tools available to help drive the momentous changes needed if we are ever to control our adverse impacts on the environment.*

### What Can the Introduction of an Environmental Management System Achieve?

Many public sector organisations are now working in this field and we are starting to see some positive outcomes, promising further improvements:

- **Contract specifications**

Long before contracts are due for renewal, specifications are rigorously examined and adapted to provide a more environmentally sustainable service. Services are designed to minimise environmental impacts as far as possible. Specifications for products aim to minimise life-time impacts of the products bought, be it at the production, use or disposal stage. This can apply to any product or product range - office stationery, IT equipment, white goods, printers and copiers or schools and office furniture. Specifications can deal with energy efficiency, toxicity, packaging and even insist that products are taken back at the end of their lifetime. The growing demand for an FSC (Forest Stewardship Council) label for wood products is a particularly welcome effort to positively influence sustainable forestry practices.

- **Procurement**

Once specifications are settled, the procurement process manages the tender processes including the selection of successful contractor(s). Where the environmental management system generates solutions, which are beyond one authority to achieve, buying consortia might be necessary. This was the case in the introduction of electric vehicles into the UK (which was helped by an international consortium of local authorities) and is also likely to be the case for those authorities that wish to drive the renewable energy agenda.

- **Building design and management**

Up to 70% of the life-time costs of a building are determined on the drawing board. Equipping architects and engineers with the necessary skills to drive down the energy, water, waste production and resource consumption of their buildings is therefore critical. Standard details can be redesigned to reflect the higher concern for environmental sustainability. The search for more sustainable materials, developing skills to design energy autonomous buildings, the integration of renewable energy systems, all become important considerations if the life-time costs of a building are to be better controlled and managed.

- **Fleet management**

There are many examples now of electric, LPG and CNG fleets in the public sector. Where these are combined with vehicle and route rationalisation and effective driver training, fleets can substantially lessen their overall impact on the environment.

- **Pump priming mechanisms**

Moving into a more environmentally sustainable direction is likely to require up-front funding. Defining and employing pump-priming mechanisms such as energy funds, created from energy savings, are therefore an essential component of the successful implementation of improvement measures. The recent climate change levy, coupled with a reduction in NI contributions has offered opportunities for ring fencing NI savings, and some local authorities have used these to progress other environmental improvement measures.

- **Skills development**

Several human resource departments are now preparing the ground for the appropriate level of environmental awareness needed in their organisation to drive the desired changes forward. In addition they also identify the levels of skills needed to be able to move ahead with more substantial and radical solutions. Preparing for change will be essential if targets such as a 70% reduction in CO<sub>2</sub> emissions (as indicated in *Environment 2010 - Our Future, Our Choice*) are to succeed.

- **Innovative services**

Driven by the need to reduce environmental impacts innovative thinking is starting to develop. For example

- waste management services are re-labelled waste minimisation;
- tough targets are set on CO<sub>2</sub> reduction, resulting in solutions that allow all CO<sub>2</sub> emissions from traffic in a local authority area to be neutralised;

- 80% recycling targets are set and result in imaginative collection and resource salvage schemes.

Imagination knows no limits and the efforts by several local authorities to use parks wood waste to feed biomass boilers, creating a CO<sub>2</sub> neutral solution, while saving on disposal costs, is just one example of innovation that can be achieved.

## The Purpose of Environmental Management Systems

EMS are prescriptive systems which allow users to identify the significant environmental impacts of their activities, products and services, develop a programme of improvements to deal with those impacts and manage them in a way which leads to continuous improvements in performance. As a baseline the systems require compliance with environmental legislation, which provides a good discipline. If this is not achieved then organisations will not succeed at the final (external) verification or certification stage. The formal systems in operation (ISO14001 and EMAS) don't require a set minimum standard of performance, but demand continuous improvements in performance. By encouraging a systematic approach, focusing on the most significant matters, these systems can provide invaluable help in improving performance. Most benefits will be had by those who use the systems to drive innovation through their organisation, eliminating waste in the process. Anybody who just wants another certificate, without wishing to go through a fundamental change process should forget it as the effort involved is just not worth it.

## A Recommended Mindset for Introducing an Environmental Management System

Both EMAS and ISO14001 are said by their authors to be designed to help contribute to environmental sustainability. The mindset required when taking an organisation through an EMS is highlighted in the recently published 6th Environmental Action Plan - Environment 2010 - Our Future, Our Choice. Here the European Commission sees EMAS as one of a few key tools which can help bring about the ambitions of the programme. This is visionary, setting tough targets to break our civilisation habits and move to a situation where the degradation of the environment and our resource consumption is slowed down to allow us to move towards a more sustainable future. The action plan recognises that we need to start thinking about targets such as a 70% CO<sub>2</sub> reduction and 50% waste reduction; it outlines the steps which need to be explored to limit our use of virgin raw materials and promotes a much more cyclic resource economy. As we all know, what is set out in the EU environmental action programmes will be handed down to national governments in the form of regulations and directives in the following years.

The action plan provides a context for environmental management systems which is highly challenging, looks far into the future and beckons solutions that require fundamental changes in what we are doing. It may be argued, and we at Global to Local certainly do this with our

clients, that the time for minute changes has passed and that the mindset for implementing a successful environmental management system should be to try to eliminate environmental impacts altogether. This may not always be possible in one step, but the ambition to eliminate the impacts rather than generate minor, often inconsequential changes, is likely to result in much better solutions.

## The Linkage to Best Value

Radical change, step-wise change, challenging why and how we are doing things are an essential part of the best value vocabulary. At the moment perhaps more vocabulary than action. Nevertheless the best value regime is in its own way trying to generate fundamental change. The linkages to an effective environmental management system are many and it is interesting to note that Circular 10/99 suggests that schemes such as EMAS and ISO14001 can *'support the necessary cultural changes required, ensure staff and members are fully involved, and create a commitment to quality and efficiency which fosters a determination to make a difference, which is the hallmark of best value'* (para 32). The added value of integrating the two systems lies firstly in the systematic approach of EMS in identifying environmental impacts, determining their significance and focusing on those most significant for improvement measures. Secondly EMS adds the management systems dimension, requiring processes and procedures to systematically manage the necessary change and ensure the system delivers. By now there are many examples of local authorities integrating the best value process with their environment management approach (or vice versa). All of these can deliver improved performance.

## Which Systems are Available?

The two formal and internationally recognised systems on the market are ISO14001 and EMAS, the European Eco Management and Audit Scheme. The latter has recently been revised and is often referred to as EMAS II. To avoid competition between the systems the European scheme now prescribes ISO14001 for the management systems part of EMAS. Both schemes have unlimited scope (all types of organisations and business) and are identical on the management systems side. EMAS however goes further primarily in two respects. It explicitly requires active stakeholder involvement, including staff involvement which, as experience has shown, is critical if change management is going to succeed. This requirement is stronger than that of the international standard. EMAS also has a public reporting stage (an annual environmental statement is required), which serves to build the credibility of organisations and leads to an ongoing stakeholder dialogue. This also serves as a spur to further improvements. Finally EMAS II is anchored in European law, through a regulation, which is the highest level of legislation produced by the European Commission. This provides a welcome balance to other European derived legislation, such as procurement rules and regulations and

can be used in finely balanced arguments about more environmentally sustainable procurement.

### What is Happening in the Public Sector?

There are now approximately a dozen local authorities, who are either registered in their entirety under EMAS or have parts of their authority registered either under EMAS or ISO14001. Some authorities move from ISO14001 to EMAS, after having tested the waters. Several large organisations (Leeds, Leicester) have taken a strategic approach and registered the entire authority in one go, while others have doggedly added unit by unit across all the Council's business units. Sutton has gone this route, and is now completely registered, Southwark are half way through their business units. For smaller authorities such as districts the approach tends to be for the whole authority to be covered in one stage. Several government departments are also registered under ISO14001.

### What are the Advantages and Disadvantages of an EMS?

If applied seriously an EMS can force the pace, focus on what is significant and help develop radical solutions. Invariably the presumption in favour of fundamental change can prompt a fundamental change to current management processes and approaches. This all presupposes a climate where change is wanted and welcome and where there is an element of risk acceptance as any fundamental change has risk attached to it. There are a number of opportunities, but also costs associated with introducing an EMS:

- As a matter of course a well designed EMS brings under control the environmental impacts of the organisation's own operations: water use, energy, waste, transport and purchasing. Substantial economies can be made in almost any organisation as highlighted by the Audit Commission in their Environmental Stewardship audits and it is worth highlighting the existence of good practice in all these areas. Any authority that applies across the board good practice in these areas should be able to make substantial efficiency savings – the total budgets for water, energy, in-house transport, waste and purchasing of goods can easily be in excess of 10% of the overall budget of an organisation.
- Applying an EMS to its own operations builds the in-house competencies needed for the authority to deal with the wider environmental issues arising from its services. These invariably also require the cooperation of its customers and other stakeholders in the community.
- Applying an EMS to its own operations and services will help create credibility with local communities and business and provides a springboard for wider introduction of environmental improvement measures across the territory administered by the local authority. Building understanding and empathy is critical if schemes such as large-scale waste minimisation, or CO<sub>2</sub> reduction schemes are to have any success at all.

- Finally, embarking on a formally verified scheme brings the Council's environmental performance out into the open and subjects it to public scrutiny. This provides a powerful incentive to drive performance as nobody will wish to lose a registration, once gained.

Against the advantages stand two main concerns:

- There are the costs of staff in setting up and managing the systems. This is an up-front investment, which needs to be resourced adequately. Results are directly related to how well the systems development stage is resourced. Costs include the time of staff or staff groups involved in setting up the system. There are also costs relating to verification / certification and regular inspections by the appointed verifiers. In addition, if choosing EMAS, there are printing and distribution costs associated with the environmental statement.
- More importantly there are the problems of integrating an EMS with the best value regime, which will require further adjustments to already cumbersome procedures. These can be overcome and there are potential win-win scenarios. They all require some time spent by best value staff each year on exploring how the services they are reviewing can be performed better from an environmental point of view as well as all the other considerations they need to apply.

### Is it Practicable Today to go for an Environmental Management System?

In view of the current preoccupation with best value in the public sector, it will require much determination to aim to introduce an additional system. However, as best value settles in, the added advantages of an EMS will become clear in particular at the challenge stage and of course in providing a firmly anchored management system for any proposed changes. Sensibly applied an EMS can help drive the changes envisaged as part of the best value process and help bring about a more sustainable future.

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# Innovation in Sustainable Development

## Managing the Environmental Impact of Leicester City Council Through EMAS

Carol Brass

Leicester City Council

*Leicester City Council has adopted the Eco-Management and Audit Scheme (EMAS) to ensure that its environmental standards are monitored, maintained and improved wherever possible. This Europe-wide scheme helps the Council to manage and improve its own environmental performance, allowing the authority to move further towards its goal of achieving sustainable development in everything it does.*

### Environmental Management – A Strategic Approach

For many years Leicester City Council has played an active role in encouraging and supporting measures which protect our environment. This was recognised in 1990, when Leicester became Britain's first Environment City and two years later was one of only twelve cities from across the world invited to attend the Earth Summit in Rio de Janeiro. In 1997 the Council decided to adopt EMAS (the Eco-management and Audit Scheme), to guarantee good practice in managing the environmental impact of the day to day operations of its services.

All City Council services except schools are included within one corporate EMAS system. EMAS required a whole authority assessment of its environmental performance which had to be subjected to external verification. Leicester City Council became successfully registered in July 1999, when it was the largest organisation on the UK EMAS register.

### Why EMAS

There were six key reasons why Leicester City Council adopted EMAS to regulate its environmental impacts:

- **Progress** - at the centre of EMAS is a commitment to improve our environmental performance that ensures continuous progress.
- **Control** - EMAS provides managers with more environmental information and control.
- **Involvement** - All staff are involved in EMAS rather than a few environmental experts.
- **Public Accountability** - EMAS demonstrates to people in the city exactly what the Council is doing to reduce its environmental impact.
- **Profile** - EMAS is a European scheme and improves the Council's national and international profile.

### Leicester City Council's Approach to EMAS

The Council has sought to place the environment and the need for sustainable development at the heart of its activities. It is committed to EMAS at the highest level and the Chief Executive is the responsible EMAS officer. The System is managed by a cross-departmental group, the "Sustainable City Officers Group" which meets every six weeks and is chaired by a director. This group is overseen by the director's board and by elected members at cabinet. One of the eight cabinet members carries specific responsibility for EMAS in their portfolio.

All Cabinet reports have a section entitled 'Sustainable & Environmental Implications' which draws members' attention to relevant issues. Business plans for all services are developed within the context of corporate plans and policies, which cover environmental issues and also include 'sustainability indicators' as well as performance indicators.

In 1999, our external verification company, LRQA reported:

*"Protection and enhancement of the environment is clearly seen as an integral part of the council's business and not to be set on the margins."*

### The Environmental Policy

Leicester City Council's Environmental Policy is the driver for the whole EMAS Scheme. It highlights the aims and principles to which the City Council is working to ensure that it takes a part in creating a better environment for generations to come. This is reviewed annually to ensure that this remains the case – for example we have strengthened the commitment to enforce environmental legislation such as noise pollution and litter removal.

### EMAS Significant Effects

Under EMAS, the Council has had to adopt environmental targets for improvement and shown how well it is progressing towards these in annual public statements. In July 1997 Leicester City Council identified a number of significant environmental effects covering a wide range of activities – some undertaken directly and some over which the Council has influence in the City. The main effects highlighted were in the following areas:

- use of finite resources
- waste
- pollution and discharges
- quality of the environment

Many of the significant effects relate to the large amount of legislation that the Council has a duty to enforce, for example controlling pollution in the City and assessing planning applications. Leicester City Council must also act within the law. So, for example, when highway work is carried out, it has a duty to control noise and pollution, just like everyone else. In addition, the list reflects the higher standards that have been adopted through internal policies – for example, in 1990 it was decided to restrict the use of tropical hardwoods in City Council operations.

## EMAS Targets and the Public Statement

These environmental effects are monitored within the management system and where appropriate improvement targets have been set. Leicester City Council has adopted 19 corporate targets for environmental improvement. These are reviewed annually and progress addressed through the corporate action plan. The improvement targets relate to the following issues:

- Council use of energy
- Council air emissions
- Household waste collected by the Council
- Council waste
- Council use of water
- Council use of paper
- Quality of natural environment on Council owned land
- Quality of open space on Council-owned land

Examples of targets include the following:

### 1. Energy

- Reduce the Council's total building energy consumption. *Reduce to 50% of the 1990 level by 2025;*
- Improve the energy rating of Council houses. *Reduce energy usage of Council houses by 30% of the 1996 level;*
- Reduce staff commuting by car. *10% reduction of the number of people coming to work by car in 2000, by 2005;*
- Reduce the fuel used by staff vehicles at work (not commuting). *5% reduction of the fuel used in 2000 by 2005;*
- Increase the use of bicycles at work (not commuting). *100% increase of 1997 levels by 2000 and 200% increase of 1997 levels by 2002.*

### 2. Council air emissions

- The above targets relate to this effect in terms of carbon dioxide reduction;
- Reduce fleet vehicle emissions. *Total emissions from fleet vehicles of: sulphur dioxide reduced by 98%, total hydrocarbons reduced by 42%, nitrogen oxides reduced by 12% of April 1997 levels by 2002.*

### 3. Council waste

Reduce the amount of Council waste going to landfill. *40% of Council waste collected in 2003 to be recycled.*

### 4. Household waste collected by the Council

Increase recycling of household waste. *40% of household waste collected in 2004 to be recycled.*

### 5. Council use of water

- Reduce water use in council buildings. *5% reduction of 2000 levels by 2005.*
- Increase the use of greywater in place of potable water. *15% of total water consumption to be from greywater by 2010.*

### 6. Council use of paper

- Reduce the quantity of paper used. *5% reduction in the quantity of paper purchased in 2000, by 2005.*
- Increase use of recycled paper. *98% of paper purchased in 2000 to be 100% recycled post consumer waste.*

### 7. The quality of the natural environment on Council-owned land

Ensure parks and open spaces are sustainably managed. *100% of parks and open spaces managed by Arts and Leisure to have corporate management data in place by 2000 and full management plans by 2005.*

### 8. The quantity of open space on Council-owned land

Ensure that the Council continues to provide Leicester people with accessible green space. *Publicly accessible green space covers at least as much land in 2020 as it did in 1994 (863 hectares).*

## Procedures

A corporate manual of procedures, and an action plan back up the EMAS system. The written procedures ensure day-to-day control and guard against accidents and emergencies, with subjects ranging from office waste recycling systems to the environmental management of its contractors.

## Monitoring

The Internal Audit programme is an integral part of the EMAS system. It is designed to cover the whole system in each year, and does so in the following ways:

- An overview audit, to ensure that all of the necessary parts of the system are in place.
- Audits of each of the significant effects the Council has identified, assessing targets and progress towards them.
- A range of service unit audits, ensuring that relevant environmental legislation and EMAS procedures are complied with.

As a result of the audits undertaken, areas for improvements are identified within the system and corrective action is ongoing. Major findings are reported to audit sub-committees and declared in our public statements.

## Staff Communication

An understanding of environmental quality is a corporate recruitment requirement. Staff then continue to receive information on the environmental management system through a number of channels:

- The staff magazine 'FACE' runs regular features about EMAS
- EMAS briefing papers
- Corporate briefing papers
- Leicester City Council's Intranet site
- Poster campaigns give positive feedback to staff on their environmental achievements
- An EMAS Helpdesk telephone number and e-mail address is available to receive and respond to any staff enquiries about EMAS.

## Staff Training

EMAS is incorporated into induction training, and courses for all staff on practical implications and application of EMAS in service delivery are organised by departments. More specialised training sessions have also been provided:

- Awareness of our environmental impact and significant environmental effects
- Understanding the EMAS procedures manual
- Environmental legislation training for specific types of staff, e.g. depot managers, building managers, estate valuers, architects and engineers.

These sessions are reinforced by campaigns relating to our targets for improvement. An example of such a campaign is the one on Air Quality in 1998. Posters were produced highlighting the benefits of using a bicycle to cycle to and from work for Council business. These were personalised by showing a named member of staff carrying out good practice and indicated promotional offers. In this instance, staff were able to submit bus tickets used to travel to work for a prize draw, a leisure centre offered free fitness tests to Council staff.

## Stakeholders, Contractors and Purchasing

Leicester City Council uses a vast range of private contractors to deliver services. These range in size from international companies (like SITA, responsible for household waste collection) through to local plumbers called out to fix a leaking tap. Leicester City Council is committed to ensuring that, when these contractors work for the authority, they adopt similar environmental standards to the City Council. Through EMAS, contractors are now asked to comply with the environmental policy and start working towards their own environmental management system. To encourage their progress, the City Council funds a support service with Environ (a local environmental charity).

Leicester City Council also has a green procurement policy in the form of "A Guide to Environmentally Friendly

Purchasing". EMAS procedures ensure that all staff purchasing adheres to this policy.

Stakeholders are also encouraged to improve their environmental performance. Specific publications have been produced for certain key stakeholders, such as Council tenants, and tenants of our industrial properties.

## Communication with the Public

Public accountability and Communication with the public is a key feature of EMAS. The Environmental Policy is available from the main customer service desk and is displayed in Council buildings and on the internet. An exhibition has been displayed at libraries and other appropriate venues in the City. In addition, regular articles on environmental issues are written in the City Council's Link magazine which is distributed monthly to every household in Leicester. There is an Environment City Website which contains a lot of information about environmental initiatives within the City and also information about the City Council's EMAS system.

The Green life page of the local newspaper, the Leicester Mercury, carries many articles on environmental issues relating to the City Council's activities. In addition, the Council is a partner to a regional environmental campaign project known as "Turning the Tide". This allows coverage on television, radio and local newspapers during the period of a campaign.

## EMAS Achievements

Through EMAS the Council has improved its own environmental performance and saved money. This is particularly the case regarding energy, waste reduction and water use, intelligent metering has been introduced at all Council sites and the Council can demonstrate good progress towards a number of EMAS targets. The decision to adopt a corporate approach to EMAS has also been cost effective in terms of staff time and verification costs. Specific examples of environmental progress include:

- **Paper:** Between 1997 and 1999 there was a 35% fall in paper consumption. At the end of this period, 95% of this paper was made from 100% post consumer waste.
- **Energy:** Energy consumption has also fallen by an estimated 8.4% since 1990. Leicester is developing solutions which will allow the Council to supply 50% of the base load of electricity used at its contract sites. It currently supplies 14 of its sites with electricity. The income generated (£150K) is passed back to the housing department for reinvestment in energy efficiency.
- **Air quality and transport services:** A comprehensive value-for-money review of the Council's transport services is currently under way. This includes: awareness training for re-fueling procedures; 'green driver' booklets issued to all vehicle managers to raise awareness; driver training to improve fuel efficiency through better techniques; and using techniques such as route planning.

The majority of the Council's vehicle fleet is run on city diesel which reduces levels of sulphur dioxide, hydrocarbons and nitrogen oxide. An electric bus is used as an education resource, giving energy efficiency advice to householders in Leicester. The Council is currently purchasing electric vehicles and liquid petroleum powered vehicles for the fleet.

A comprehensive survey looking at staff travel has recently been carried out and the results are currently being analysed. Campaign leaflets have been issued to employees encouraging the use of cycling and buses on Council business. The Council will pay mileage if employees cycle on council business and in 1998-1999 50% more cyclists claimed mileage payments than in the previous year. A bicycle user group has been set up to encourage and support staff using their bicycles for work and a cycle map has been produced. The map indicates off road cycle routes, designated on-road cycle routes and preferred routes along quieter roads.

In response to immediate public concerns and to reduce congestion a series of measures has been introduced including "Leicester Environmental Road Tolling Study" (LERTS) - a comprehensive quality bus priority corridor with associated park and ride to enable a road user charging experiment to be run by the DETR. The use of the Park and Ride has exceeded expectations and the Council is currently working on a safer routes to school initiative and a real time bus time information system.

- **Waste:** Within the main city centre Council buildings' recyclable waste is collected separately and taken to the City's recycling facility and there is a contract to recycle redundant Council computer equipment. Currently Leicester City has a recycling rate of approximately 10% for household waste. The target of 40% will be achieved in 2004/2005 when a new biowaste facility becomes operational, the facility will compost a large proportion of domestic waste with only the residue being landfilled.
- **Water:** In 1998/99 water use fell by 10% from 1997/98 levels. Many City Council sites are fitted with "sub-meters" to identify local water use and building managers receive regular water consumption reports. A greywater project is now in place at one of our golf-courses to collect and re-use rainwater for watering the greens.

## Future

Our key priority for the immediate future is to ensure that our strategic approach to environmental management is embedded in the current changes happening to local authorities under the Modernising Local Government agenda. For example, we are working to ensure that our EMAS system is thoroughly integrated into Best Value reviews and to the aims of Leicester's Community Plan. Our next environmental public statement has been redesigned to link with the Council's annual performance plans. Future statements will take account of the increased flexibility allowed under the revised EMAS standard and also the good practice observed from the business sector.

The environmental system is being extended to include schools. Whitehall primary school will be the first school in the country to be registered under our EMAS system in April. Our priority for next year is to pilot the inclusion of a secondary school in the EMAS system by the end of the year.

The City Council intends to improve its internet sites to include more environmental information and develop further opportunities for obtaining feedback and sharing good practice with other partners.

## Conclusion

Leicester City Council has been fortunate to have received a number of environmental awards over the years - In 1989 we were awarded the title Britain's First Environment City, and in 1996, the title of European Sustainable City. These are hard titles to live up to! People will quite rightly start to ask what we have achieved to deserve them? We believe EMAS is providing us with the tool to be able to answer that question.

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## “Sustainability for Real”

### Neighbourhood LA21 in Telford & Wrekin

Robin Mager

Telford & Wrekin Council

*“What’s the best way to get people involved in Local Agenda 21 and sustainability?” That was the question facing Telford & Wrekin Council back in 1995 when it began its LA21 process and established a series of topic based Round Tables. To date, more than 250 people and organisations have participated in numerous projects from creating environmental policies for schools, to working with a developer to build homes with rainwater harvesting systems. Late in 1999, the Council organised a re-visioning event for all the LA21 partners to look at how the process could be refreshed and moved forward. One key thought that came out of the event was the need to involve people on an even more local level! So the idea for creating a network of neighbourhood LA21 groups arose.*

Telford & Wrekin Council is taking two approaches to try to encourage more people to become actively involved in LA21. The first involves the Local Agenda 21 officer working with existing volunteers to create neighbourhood LA21 groups in their communities. Two of these environmental champions have worked closely with the officer to make things happen in their neighbourhoods.

Of course volunteers, willing to be actively involved, are often in short supply and so the Sustainability for Real project was devised to generate interest and participation in several other areas of Telford & Wrekin. The project was made possible when at the end of 1999 Telford & Wrekin Council was successful in attracting European funding for a one-year pilot project from the ERDF under Objective 2 with matched funding from Telford & Wrekin Council. The initial idea was to support the people of Donnington Wood and Oakengates (both Objective 2, Priority 1 areas) in creating environmental and economic regeneration. This was to include implementing physical improvements in the local environment, promoting sustainable changes in lifestyle and improving employment opportunities.

#### The Project Begins

The first step once funding was in place, was to employ a Sustainability Projects Co-ordinator and to engage the services of the Neighbourhood Initiatives Foundation (NIF). NIF had developed the “Planning for Real” process, which would provide a good basis for this pilot project. “Planning for Real” was first used in 1977 to overcome ‘us versus them’ conflicts at public meetings. The process is visual, allowing participants from all sectors of the community to show their concerns using a large 3D model. As the focus is on the model there is less conflict between personalities and those with less confidence are able to have an equal input.

Following feedback sessions, a strong partnership developed between local people and outside ‘experts’. The idea was to use and adapt this process to raise awareness, gather local people’s ideas and comments on how their local environment and quality of life could be improved; and also to provide a starting point for forming neighbourhood LA21 groups.

#### Stakeholders

One of the first tasks was to hold stakeholder analysis sessions in which key players in each area were invited. These exercises helped to identify not only the various existing stakeholder groups, but also possible venues, approaches and times which would be most appropriate for making contact with the public. These sessions also highlighted the concerns of various existing organisations and the partnerships in the respective areas.

In one area, a community partnership had already undertaken a great deal of similar work while in the other a European funded regeneration partnership had recently been established. One of the challenges was to find ways that the Sustainability for Real Project could help augment these existing initiatives.

Unfortunately these sessions were not as productive as hoped, although a great deal was learned from the negative response of some stakeholders. Underlying this response has been the existing extent of community involvement (and who was seen to own this) as well as ‘consultation fatigue’/disillusionment and a feeling that either ‘sustainability’ was not considered an important or priority issue or that duplication of effort was likely to occur.

As far as possible the concerns raised at the stakeholder sessions were taken on board as was the appreciation that unlike traditional “Planning for Real” this project had not initially been generated from within the community. Revisions made to the project at this stage included:

- targeting groups identified as ‘hard to reach’ in previous consultations e.g. older people and youth;
- rearranging times and locations to best fit existing local events;
- detailed changes to the consultation method (type of information requested, themes of suggestion cards, etc);
- redefining the areas covered and who could make maximum use of information gathered.

Ongoing communication with the partnerships, including active and ongoing involvement with sub-groups, has maximised the potential benefits from this project.

## The Model

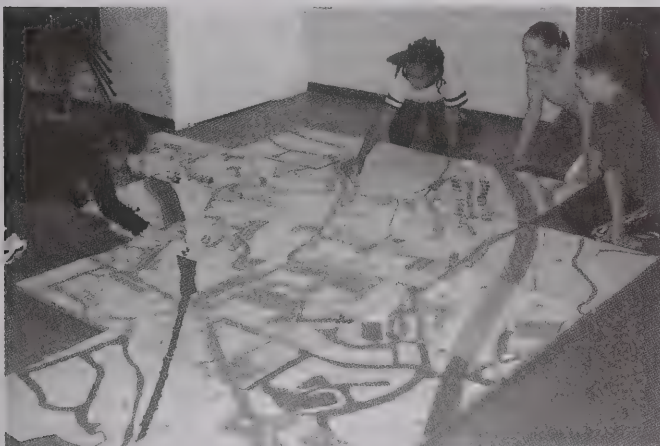
The other key task to complete before the road shows could be held was the construction of a large (1:300 scale) 3D model of each of the two areas and the creation of a wide selection of 'suggestions cards'.

Before the model could be started a substantial amount of work was involved in producing 1:300 versions of local maps and especially in surveying the area. A survey was needed to establish what housing types were present, the appearance of specific and landmark buildings (with accompanying sketches and preferably digital photographs) and types of land use.

In our case the timetabling of the project meant that it was impossible to fit the model making into school term time. The model making was a good way of involving children in the project and also their parents. The solution in this case was to contact summer play schemes in the area, a move that proved very successful as it provided an additional activity for the schemes and reduced the workload on hard pressed youth workers.

The model making was undertaken in line with NIF's guidance and their "Planning for Real" pack provides building types ready to photocopy, cut out and construct. The combination of paint, children and a community/environmental theme was popular with the local press and significant coverage was gained in newspapers and on the local radio.

The 'suggestions cards' and some of the other consultation material were produced by NIF according to the requirements of LA21 and feedback from the stakeholder groups.



*Model making in progress*

## Venues

These were chosen to maximise the possibility of local people being able to attend, covering a wide variety of times, days and locations, from a working men's club to a church and youth clubs to Salvation Army OAP events.

## Publicity

The publicity benefits of involving children in the model making process have already been mentioned. In addition to this numerous posters were printed and displayed, leaflets

delivered door to door (with the help of probation services) newspaper articles and live interviews on local radio were arranged. The publicity seemed to vary in effectiveness between the areas.

In Oakengates there is a central focus of the town centre, with numerous shops, a library, several public houses, an information centre and Housing Trust Shops. Also the presence of a regeneration project helped to spread the word. However in Donnington Wood there are only a few shops, a working men's club and the church. Although posters were also displayed at a nearby library and various community centres the effectiveness of publicity was less. The degree of publicity and the range of suitable venues in each area mirrored public attendance at the road shows.

## 'Green Connections' Road Shows

The ten road shows were held over a two-three week period late in 2000, with the assistance of NIF staff. Throughout the events at least two 'staff' were on hand at any one time. Extra help was obtained by recruiting volunteers from within the ranks of Telford & Wrekin Council staff.

In addition to the model the events themselves consisted of a combination of display information, pin boards to record information on participants (age, gender, location of residence) and act as a counter to record the numbers attending each event. Additionally a local environment quiz was included with 'eco-prizes' as the reward for participating. For several reasons (including the time of year, practicality of locating a large model at available venues and the objective of trying to identify those who would be willing to get actively involved - rather than as many people as possible) the events did not incorporate too many gimmicks.

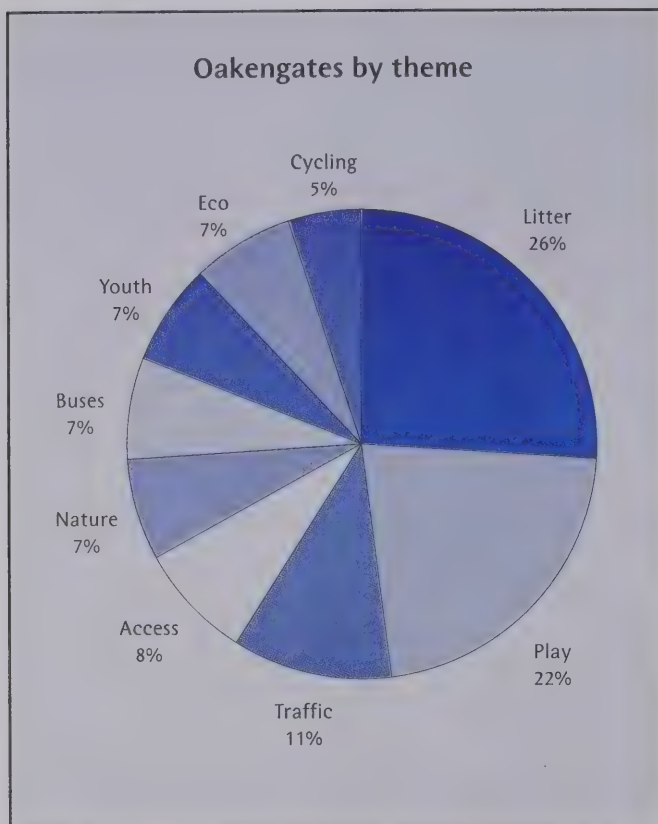
People were encouraged to look at all the information on display (which included both global and local issues) and to browse through the 'suggestion cards' looking for any that they felt were appropriate. Blank cards were also available for the many ideas that we were unable to foresee. The cards could then be placed on the model to indicate the location of the problem, suggestion or solution. General ideas that had no specific location were placed around the edge of the model in the bordering 'no-man's land'. At the end of each session the results from the model and pin boards were recorded.

## Post Road Show

Despite trying to focus on activities that they themselves could become actively involved in, some saw the events as an opportunity to 'moan' without being willing to take any positive action.

However the road shows have served their purpose both as a pilot into the effectiveness of the "Planning for Real" in generating involvement in the LA21 process and in acting as a focus around which neighbourhood action could evolve.

In Donnington Wood the low initial response has meant that further work is needed. A local tenants association has been identified by the community partnership as the most



Combined road show results grouped by themes

suitable group with whom to develop sustainable projects within this area.

The higher response in the Oakengates area has meant that progress here has been relatively rapid. Within a month all those members of the public who had expressed interest had been contacted and a meeting held to prioritise their ideas in a structured way. This initial meeting was attended by over a dozen people and resulted in a number of projects being identified that they felt would help to improve the local environment. These include creating a BMX track/facility, taking part in a Recycling Sticker Campaign, Junk Swap Days, setting up a Garden Share Scheme and organising targeted litter picks.

To help promote the Group, the Sustainability Project Officer has, with help from a local doctor and staff and pupils at a nearby secondary school, created a 'Green Connections' web-site ([www.oakengates.green.com](http://www.oakengates.green.com)). A bi-monthly newsletter has also been produced which is distributed through local shops, library, etc.

### Ketley Bank - The Project Expands!

As the project progressed it became increasingly clear that it was costing less than had originally been anticipated. This was due to a large extent to the degree of support that the project received from numerous organisations. An extension of the project was therefore negotiated, with the Government Office, West Midlands. This allowed us to maximise the resources available in the project period and to pilot some modifications, developed to address some of the problems identified with the first stage of road shows.

This time stakeholders in the Ketley Bank area (e.g. Councillors, local junior school, relevant local authority officers) were approached and asked for their views on the project and whether they could see it as beneficial for the area. Having been assured that they felt the project worthy and suitable they were then asked to support our position in the negotiations over the possibility of using the existing funding to support the Ketley Bank expansion. In short we were invited into the area.

While this area is more defined than the previous areas there are very few facilities (including venues suitable for a road show or open day). It was decided to hold two events both at the community centre on a Friday afternoon and evening and all day Saturday.

Rather than construct a model a large aerial photo of the area was on display to give an overview of the area. We suggested to those attending that the "Planning for Real" process may provide an approach that would enable them to tackle some of the problem issues in the area. In addition to the display material on environmental / sustainable issues we included displays from NIF highlighting what had been achieved in other areas.

The pin boards were abandoned and a questionnaire was used to identify issues but more so to record contact details and to find out what people felt they would need (in terms of training, materials, support, etc) to be able to make a positive contribution.

Additional features to these events included the distribution of low energy light bulbs (from Npower on behalf of the Telford & Wrekin Sustainability Trust), a participation / action pack (including maps, aerial image of the area, neighbourhood skills survey form, etc) and a juggling workshop.

The Ketley Bank events were publicised locally with posters in local shops, the junior school, doctor's surgery, etc and leaflets delivered door to door, this time by the Project officer who could chat with local residents as the opportunity arose to promote the event further. The events were also featured in the project's "Green Connections" newsletter, in the local free paper and on the local radio station.

The attendance and response was good and there is a definite feeling that a more positive contact has been made. The next stage will be to re-contact those who expressed a positive interest to arrange a group meeting to find out who every one is and how they can take their initial interest further. To help in this substantial assistance is needed, from office support (typing, photocopying, printing, laminating, mail shots, e-mail & website) to "Planning for Real" training (provided by NIF), and from use of facilities and materials such as display boards and digital cameras to assistance in constituting a group and accessing external funding.

### Conclusion

As a pilot project Sustainability has proved very informative in testing new approaches towards sustainability in the Telford & Wrekin area. Ultimately the success of the project

relies on acting on some of the lessons learnt in future projects.

### **What we've learnt:**

#### **Pros**

- This kind of approach can be very cost effective. Actually being seen to be active at 'ground level' gives a very positive message (almost equates to bobbies on the beat) and generates considerable support;
- Ability to access new sources of funding through community groups themselves or interested environmental trusts who may have concerns in directly funding "Council projects".
- Value of a human approach.
- Non-aggressive non-adversarial technique of "Planning for Real" generates responses from those excluded from more traditional forms of consultation and allows 'voices' that are often swamped to be heard and included in the process.
- Potential of 'holistic' project pulling in diverse individuals and organisations. This is also promoted by the "Planning for Real" approach and an informal and non-aggressive approach. The result is that meetings can see people as varied as the local vicar, youth workers, teenage BMX tearaways, town centre co-ordinator, councillors, single mums, families, etc.
- Even without the end results the project has raised awareness of the issues around sustainability, allowed people (often those considered to be socially excluded) to see that there are ways that they can have a positive input and make a difference.
- Contribution made by comments at the road shows and by local groups to core Council services, e.g. waste/recycling. Valuable feedback has also been channelled to a range of council officers that can assist them in carrying out their duties.

#### **Cons**

The size of the model can restrict venues as well as the options for 'piggybacking' other events. (It's hard to be unobtrusive with a space requirement of 20 x 20 feet.) It also meant that a vehicle had to be hired to transport the model and the trestles needed to stand it on. Other disadvantages identified included:

- Seen to some extent as a vehicle for 'complaint', rather than involvement in addressing the issues. However while complaints tend to outnumber positive ideas, trying to get beyond the initial complaint and to some of the underlying causes has produced interesting insights for both parties.
- Still seen to be initiated outside of the 'community'.
- 'Holistic' approach means that this kind of project can be seen as duplicating the work of others, or working within their 'territory'.
- Informal approach means that attendance at meetings is varied and sporadic.

- Unconstituted groups will have difficulties in accessing funding.

#### **Beware**

- Stakeholders need to be approached with great care. This is perhaps especially true for local authority projects, itself a contentious stakeholder!
- The problems of balancing true open consultation with a lack of direction and focus.
- How much the term 'sustainability' means to most people. You can actually see eyes glaze over. Although perhaps not ideal 'green' seemed to be the most widely understood term. There are significant advantages of not marketing the sustainable angle at all, but to point out that best practice would mean that x, y and z can only really work in the long term if certain sustainable features are built in.
- The degree of apathy and lack of positive interest in communities. Who are the communities? Can you 'buy' a good one off the shelf?
- What works in one area needn't work in another.
- Practice what you preach (i.e. refreshments at all the events and meetings have been organic, use of recycled paper, prizes are environmentally friendly, waste is minimised, etc).
- Confusion over the number of new initiatives, projects, strategies, policies, etc, most of which have little or no discernible impact at ground level.
- Consider existing partnerships, projects, initiatives, etc and their sense of ownership in the area.
- Take care before attempting to create 'stand alone' LA21 groups where other existing groups are better placed to take projects forward.

#### **Where to Now?**

Telford & Wrekin Council is committed to encouraging more people to participate in Local Agenda 21. The aim is to create a network of LA21 focused groups across the District that will be able to offer support to one another. The need to provide basic ground level support is very important.

Feedback from several other 'Sustainability for Real' Projects across the West Midlands (linked through the West Midlands Environmental Network) will help to develop best practice and assess which kinds of approaches may best suit particular areas.

Further development of the project is planned which seeks to explore more ways of utilising and supporting existing local organisations in moving towards practical sustainability. This would ideally include the formation of community businesses.

For further information please contact Robin Mager, Sustainability Projects Co-ordinator, Telford & Wrekin Council, Tel: 01952 202547.

# Innovation in Sustainable Development

## Progressing Sustainability Through Partnership

Weald WoodNet

David Saunders

East Sussex County Council

### Introduction

*One of the issues which generated enormous amounts of debate following the Kyoto summit was the role of forests as carbon sinks. Whilst not the most significant absorbers of carbon dioxide on the planet, trees are important, mainly because they are to some degree within our control, unlike the algae in the sea, or soil-borne bacteria.*

The loss of forests globally has been blamed for the increased carbon in the atmosphere. Not only is CO<sub>2</sub> generated when the trees are cleared and burnt, but the capacity of the forest to continue to absorb CO<sub>2</sub> is lost.

However, it is also true that forests, in the northern hemisphere at least, are expanding, and annual tree increment has been increasing over recent decades, attributed by some to increased availability of CO<sub>2</sub>, a limiting factor to plant growth in some instances. In developed northern countries, sustainable forest management is being carried out in the majority of cases, and yet just a fraction of the potential harvest which is building up at a rate of 4.4 m<sup>3</sup> /second is being harvested and used.

Existing forests have often reached a steady state, where absorption of atmospheric carbon by new tree recruitment matches the release caused by the process of wood decay. The capacity of an established forest system to absorb more carbon is therefore limited. By creating new forests, the overall capacity can be increased, but as this takes place on vegetated land, where some absorption already takes place, the net effect is limited. There is, however, a perspective which recognises that if the growth of the forest can be captured at a time of maximum growth, and retained as long-lasting timber products, the capacity of the forest as a carbon sink can be increased.

Whilst these debates are fascinating and challenging to our understanding of the operation of the carbon cycle at a global level, at a European or national scale, the practice of renewable carbon management is still a long way off being a significant means of achieving the double benefit of increasing the net carbon storage in the biosphere, whilst at the same time substituting for the continued use of fossil-derived carbon.

Despite the international communities' efforts to reach agreements on target setting and identification of appropriate indicators, in order to effect change it will also

be necessary to deliver solutions which work at the local level. East Sussex County Council, in conjunction with the other partners in south-east England, and more recently in Europe, have been working together to develop a 'WoodNet' partnership model, which addresses the economic, social and environmental benefits of sustainable development of the forest resources of the region.

Whilst the UK is not high in the international league table of forest land, a significant area of the south-east England is under trees, with woodland cover exceeding twice the national average. Some parishes in East Sussex have a land area in excess of 40% under trees. This provides many important benefits, including a significant contribution of landscape and biodiversity.

However, over the past few decades, the timber production function of the woods in the region has diminished, yet at the same time timber and wood products continue to form one of the country's biggest imports. The importation of timber on such a scale results in some serious environmental impacts. Not only is there the concern about the effect on forests in developing countries, where environmental protection is secondary to the need for foreign currency, but there is also that of large-scale global transport of bulk materials, which further contributes to the problems of increased carbon emissions.

The spread of messages such as 'plastics are better than timber, because no trees are cut down' continues, even amongst the environmental community, and whilst recycling can be a worthwhile mission, it is far more efficient to ensure that our needs are met from renewable resources in the first place. Unfortunately, our long-standing dependence on the exploitation of timber resources from other countries, has resulted in a gradual neglect and decline of our own woodland, and a diminution of understanding amongst timber users and the buying public as to their value as a source of everyday items.

Woodlands in south-east England have been actively managed for many generations, and the ecology of our lowland broad-leaved woods has become adapted to the cyclical harvesting and regeneration, especially under coppice systems. Many of these forests are "ancient", derived from the original "wildwood", but modified over centuries by harvesting for raw materials – fencing, building materials, and fuel-wood, to meet local needs. This long history of management has created a "semi-natural" woodland ecology, well adapted to cyclical harvesting and regeneration, creating habitats for many species, some now

rare in less wooded regions. By abandoning the management of our woods, in favour of meeting our needs through the world market of imported timber and plastics, there has been a serious decline in biodiversity, harm to the landscape, and loss of local jobs.

## Partnership Development

In East Sussex with one of the highest levels of important ancient woodland in the UK, the County Council has had a long-standing commitment to the protection of trees and the associated semi-natural habitats. During the 1980s the emphasis shifted from protection and preservation of trees to a more active longer-term conservation approach, which recognised the historic inter-relationship between woodland management and environmental, economic and social outputs from sustainable forestry.

In the early 1980s, with serious challenges being made to the expansion of monocultural afforestation in the uplands of Scotland, all parties concerned were faced with a very polarised situation, the main points of debate being “conservation versus timber production”.

As a response to the need to find a neutral zone for informed debate on the role of trees and woodland in the lowland context, East Sussex County Council established a County Woodland Forum in 1985 which created a foundation for future partnership working. The deliberate decision was made that the Forum would not be a County Council sub-committee as it was recognised that the participation of local stakeholders was necessary for full ownership of any solutions generated. This had some positive results, with foresters and environmentalists recognising the extent of common ground, and the realisation that there was more to be gained from co-operation under the sustainable development “banner”.

Working partnerships were built on some early initiatives which became jointly owned, such as the (then) new Parish Tree Warden network, first launched in East Sussex, and the drafting of a more ambitious Trees and Woodland Strategy published by the East Sussex Woodland Forum in 1990. These joint ventures involving public, private and voluntary interests met these challenges together, which resulted in each sector recognising that they had substantially more in common, than the perceived differences that first separated them. From this starting point East Sussex County Council decided to continue its investment in partnership working in the woodland and environmental business sector.

## European Connections

In 1995 East Sussex County Council established a partnership of landowner, timber industry, local authority and government representatives to seek better ways of achieving sustainable development of the woodland resources of south-east England. The initial plans were inspired by a visit to investigate the workings of the Filière Forêt-Bois in Normandy, France, where a healthy and vibrant forest-based industry had developed, and adapted to using locally-produced raw materials, with a substantial

re-investment in local communities and, most importantly, the woodlands themselves.

Taking a lead from our French colleagues, East Sussex County Council, along with the Forestry Commission, Timber Growers' Association and a local timber manufacturer set about designing a network which crossed the traditional boundaries between economic development and environmental management.

This partnership - Weald WoodNet - was successful in securing European funding under the EU Life programme in order to develop a wood industry support network in south-east England. Match funding, and commitment of time from each of the partners, was secured, and a three year programme of research and promotional work was planned. One of the key challenges was to re-establish a link between the traditional woodland owner, growing variable quality hardwoods and the many local users of timber who found it easier to source their requirements for overseas.

## The WoodNet Life Programme

Through partnership working with the key stakeholders - landowners, woodland contractors, timber industry, government (local and national), and the public - targets were set, and resources applied to the following areas of work:

### **1. Improve the links between growers and users of wood, thereby re-establishing the local supply chain which has diminished over recent decades.**

This target was met through the establishment of the WoodNet database, and the subsequent production of information exchange materials, including WoodLots - a bimonthly “exchange and mart” magazine advertising locally produced timber parcels, aimed at encouraging manufacturers in wood to utilise local resources, rather than accepting imported timber as the only option. WoodLots is now well established, and has been launched nationally, with a sister publication “Eco-Ads” following in its success. This system has been successfully translated to the web, where [www.woodnet.org.uk](http://www.woodnet.org.uk) provides easily accessible information of materials on offer and wanted, as well as services and listing of events and training courses.

### **2. Raise awareness amongst the general public of the importance of woodland management to sustain environmental quality, landscape, ecology and the role of trees in ameliorating atmospheric pollution, and providing CO<sub>2</sub> sequestration.**

With the rise in consumer power, and the concern expressed by the public into the origins of timber, work was necessary to reassure the buying public that sustainable woodland management was a beneficial activity, and that by concentrating this work in the UK, we were not exporting our consumer-fuelled environmental damage to developing countries. Initiatives developed by the partnership included the creation of an annual WoodFair in East Sussex, where in late September each year many thousands of visitors can learn about the wood story. This is more than an educational exercise. By supporting the local manufacturers represented who demonstrate that local products can be made into

beautiful and useful things, this has the added benefit of directly sustaining the local woodland environment. Getting the message across to the public has been carried out in several other ways. Publications, such as the 'Working for Woodland' magazine and the East Sussex 'Woodland Web' Internet site ([www.woodnet.org.uk/woodlandweb](http://www.woodnet.org.uk/woodlandweb)). The publications provide information resources, in an attractively designed format. Further dissemination materials are planned, including a video, and links from the Woodland Centre to the Plumpton 'virtual' College providing distance learning.

**3. Develop prototypes and designs which demonstrate the suitability of locally produced, sustainably-grown hardwoods, to substitute for plastics and imported hardwood timber.**

In order to demonstrate the use of locally produced timber resulting from the restoration of neglected woodland in the region, a project was undertaken by High Weald Design, part funded under the EU Life programme, to work with chestnut coppice and low quality oak thinnings to develop a range of interior furniture, forming part of a "Green Office" exhibit at Olympia in 1997.

A major component of the timber used in the UK is in building. Unfortunately, timber specifications for building have been dominated by imported species, leaving little opportunity to specify native hardwoods for high quality structural use. With the support of donations from local timber merchants, Weald WoodNet commissioned structural research with the Building Research Establishment to develop British Standard codes for British-grown oak and sweet chestnut, enabling these species to be specified for structural use in buildings.



Local wood-using industries in East Sussex

**4. Create a Woodland Enterprise Centre in the Weald to provide an educational resource to serve the WoodNet, providing office accommodation, workspace and retail facilities in a development which demonstrates high standards of environmental design.**

As a demonstration of the use of locally-sourced timber in a high-quality application, an architectural competition was held, to develop a Woodland Enterprise Centre, which used

building materials derived from lower-quality, locally sourced timber, typical of that found in neglected small woods in the region. The winning design for this Centre proposed a structural gridshell of sweet chestnut, supported on a framework of softwood thinnings. This design has now been assembled, and the final fitting out is taking place this autumn. This 550m<sup>2</sup> office and exhibition hall / training room is the first phase of the Woodland Enterprise Centre Development, and planning permission has been granted for additional workspace for wood industries. Again, part of the inspiration for this came from the networks of "Maisons de la Forêt" which exist throughout France.

**5. Undertake research and education into the use of wood, as a practical means of generating heat and power from waste wood, and forestry residues, and demonstrate its application at a small and medium scale.**

Wood energy is still the most extensively used fuel in the world, especially in developing countries where the over-exploitation of natural resources is putting great strain on forests.

Part of the Woodland Enterprise Centre plan involves the creation of a wood energy demonstration unit, to use local wood waste, and forestry residues to generate heat and electricity for the Centre. Sufficient timber grows each year for a much larger-scale use of wood as a renewable fuel, and this could substitute for a significant quantity of fossil-derived carbon, thus reducing CO<sub>2</sub> emissions. Indeed, the regeneration of woodland rapidly re-absorbs the carbon dioxide released from wood burning, thus creating a closed "carbon-neutral" energy cycle. A feasibility study has now been completed, and backers are being sought to implement this facility.

## Woodland Enterprise

More recently, the WoodNet partnership has formally constituted itself as Woodland Enterprises Ltd (WEL), a non-profit company limited by guarantee, bringing on board Plumpton College to support the increased educational role of the project.

Following from the WoodNet Life programme, it was necessary to formalise the partnership and, through this new public / private sector organisation, an educational resource and business centre to serve the WoodNet in the south-east of England has been established. A Woodland Enterprise Centre master plan was developed which comprises a mixture of industrial workspace and offices, combined with visitor and educational facilities, all focusing on the utilisation, adding-value, and support for the wood sector.

As a result of this initial feasibility work and business plan, WEL were successful in winning a Rural Challenge award, £1M towards the creation of a Woodland Enterprise Centre, where the opportunity to demonstrate sustainable development is taking place.

## Rural Challenge Programme

Over the past five years the WoodNet partnership has worked together to develop a range of technical solutions, publications and information materials, and has been successful in raising substantial financial support to continue the ambitious Woodland Enterprise Centre development plans into the future.

The key to this vision was the creation of a sustainable building system using local small roundwood, demonstrating high environmental standards, and fuelled by renewable wood energy. Outline planning permission was granted in 1998 and, following an architectural competition, detailed approval has been gained for the first phase of the workspace development for wood-related enterprises.

The first building at Flimwell is nearing completion, and will serve as offices and exhibition / meeting training facility for use by woodland and land management organisations. This building is itself, a prototype of sustainable construction, utilising local wood throughout, including sweet chestnut as structural timber, in joinery, flooring and external cladding. By demonstrating how the low-value coppice can be used for high-value uses, the message can be transmitted to a wider audience, and encouragement for continued traditional coppice management will be provided as the building system develops.

## European Partnerships

Working with French forestry and environmental organisations has provided significant inspiration to more effective use of resources by working in partnership. By adopting and adapting the 'interprofessional' networks that exist we have been able to multiply financial resources and exchange of resources and skills that would not have been available to any one sector working on their own. The

WoodNet partnership has recently received confirmation of support under the EU INTERREG programme to extend the research and development work to undertake joint actions with colleagues in the timber industry in Normandy, Picardy and Nord-Pas de Calais. As well as working with our nearest European colleagues, there is scope to extend the geographical boundaries of partnership working through involvement in the European Forest Institute, based in Finland.

## Conclusion

Partnership working has been an effective way of making sustainable development in the regional wood sector happen at a local level.

However, like growing trees, the establishment of the WoodNet partnership has been a long-term process, but the results are beginning to make an impact, and a method of working has been set up which should continue to develop strongly in the future.

Opportunities for further partnership working exist in Europe, not only in the field of land management, but also among disciplines such as renewable energy and architecture, where by developing means to encourage an increase in the utilisation of wood as a material could contribute a greater share of the solution to absorption of carbon emissions.

Weald WoodNet is a partnership supporting the sustainable development of the woodland resources of South-East England.

David Saunders, County Woodland Officer, East Sussex County Council.

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## Community Wardens in Practice

*The last few years have seen a steady rise in the number of neighbourhood and community warden schemes being set up by local authorities across the UK. They often differ widely in their character and function, but all share the same basic objectives of improving local service delivery and quality of life for the people who live and work in the areas in which they operate. Many of these initiatives started life with crime prevention and reduction in the fear of crime as the central driving force, but others have shown that wardens can be used effectively to improve local environments, particularly urban environments, notably for the control of anti-social behaviour and "minor" environmental offences.*

In this article, we highlight three different schemes operating within widely removed parts of the country – Medway in Kent, Darlington in County Durham, and Newport in South Wales. Firstly, however, Susan King, OBE, Head of the Neighbourhood Wardens Unit at DETR, introduces the work of the Unit and speculates on the future development of warden schemes in the UK over the next few years.

### Neighbourhood Wardens

The Neighbourhood Wardens' Unit (NWU) was set up following recommendations in the Policy Action Team (PAT)6 report. The Unit is jointly funded by the Home Office and DETR and is part of the Neighbourhood Renewal Unit within DETR. The concept of neighbourhood wardens has a high profile with references in the Rural and Urban White Papers and the National Strategy for Neighbourhood Renewal.

£13.5M of Government grants have been allocated to 86 warden schemes across England and Wales. The 86 schemes consist of 60 local authority-led schemes, 22 registered social landlord, 3 voluntary sector and 1 is police-led. The projects are a mixture of patroller and super caretaker warden schemes. There will be independent evaluation of all schemes so that evidence of what works can be widely publicised. It is hoped that the independent evaluation will also highlight the cost benefits of warden schemes.

Wardens perform a variety of roles depending on the needs of the neighbourhood where they operate. They provide a reassuring presence acting as the 'eyes and ears' of the police, local authority and the community. Their work complements that of the police and the local authority. Duties include: patrolling, escorting vulnerable residents to shops, providing crime prevention advice, supporting new tenants, reporting litter, graffiti and damage to the appropriate authorities. Wardens can assist with tackling racial harassment, have a positive impact on anti-social behaviour and contribute to effective housing and neighbourhood management.

The NWU is happy to offer advice to anyone running wardens' schemes, or partnerships considering setting up a

neighbourhood wardens' project. A wide range of support materials has been produced. These include:

- Neighbourhood wardens information leaflet
- Newsletter (quarterly)
- Guide for Warden Managers - The First 100 Days
- Wardens' Induction Training Guidance
- Neighbourhood Wardens' Conference Report: Perspectives from Europe and America
- Neighbourhood wardens video, 4 case studies.

Conferences are being organised in every region in order that warden practitioners can get together locally and form their own support networks.

Training for warden managers has been organised by the NWU in conjunction with the Home Office Crime Reduction College. We hope that there will be an NVQ for neighbourhood wardens available soon. This will help to reinforce the message that there is a career path as a neighbourhood warden.

Copies of materials and information about courses and events can be obtained from Nicola Rochester Tel: 020 7944 2535.

### Community Safety in Darlington

In December 1999, Darlington Borough Council and Durham Constabulary began to develop a strategy around the provision of street based community safety and environmental management. A small working group was established to design a service whose principle commitments would be

- High visibility
- Public confidence
- Absolute collaboration with police service
- Multi-tasked.

The key models used were continental experience with town police and state/regional law enforcement and the American model of county and state police. Aspects of warden services in both areas looked initially promising, but were predicated on existing two (or three) tier policing, which did not exist in the UK. This issue became critical when it was decided to recommend a service consisting of uniformed wardens with Council enforcement powers.

As thinking progressed it emerged that any high visibility street based service was likely to become the front line in council services. This was re-enforced by consideration of the community safety maxims :

- Nothing ruled in / nothing ruled out
- Quality of life affects experience of community and perception of safety.

In addition, in order to offer a useful addition and counterweight to Policing Services in the criminal sphere, Darlington's uniformed wardens would have to address all aspects of civil enforcement and quality of life issues traditionally associated with local authority activity.

The first warden was employed in May 2000 with support from the Home Office's reducing Burglary Initiative [(i)] (RBI[(i)]). The wardens' core role is:

- preventing crime (particularly burglary)
- delivering high visibility foot patrols (often in partnership with beat officers from Durham Constabulary)
- addressing key environment issues, such as litter, graffiti, dog fouling, parking and anti-social behaviour.

Wardens are jointly managed by Darlington Borough Council and Durham Constabulary and draw upon the wide powers and resources of the Youth Offending Team, Community Safety functions and the Drug Action Team, which are jointly managed and co-located as a single site.

Performance management was focused on two key performance indicators:

- The level of burglary in the areas in which wardens function, and
- the approval rating of residents.

Joint working with Durham Constabulary resulted in a reduction in burglary of, in some areas, 40% and public approval rating of over 84% (the next most approved service being road maintenance with 25%).

The scheme was initially modelled on American experience and contained 1st tier policing, and the uniform adopted reflected these roots. Eight pointed hats, stab proof vests and a clear approach to quality had a tremendous impact on the streets of Darlington. At one stage over 1500 letters were received following local press stories.

One factor that has reduced the impact of the scheme on the streets has been the overwhelming desire of residents and voluntary sector groups as well as elected members and various consultation meetings for a warden to attend and explain the scheme. As initial lessons have been absorbed the service is employing a senior warden, totally devoted to supporting community groups and resolving community problems to enable front line wardens to deliver enforcement services through foot patrols.

The service is quick to extol the importance of:

- Public reorganisation
- Enforcement power as deterrents
- Coordination of service delivery
- The power of visual signals.

Darlington will be reviewing all its street based enforcement activities through 2001 in Best Value Review "Street Safety" and will incorporate the lessons learned from its uniformed wardens service in that review.

**Contact:** Keith Atkinson, Assistant Director of Public Health, Darlington Borough Council, 11 Houndgate, Darlington, DL1 5RF. Tel: 01325 388582.

## Medway Warden Service

The Medway Warden service is a dynamic front line service for the people of Medway. The wardens are key to the Council achieving its core values of improving the

environment and fostering citizenship. The current service has been in operation for approximately one year and comprises 16 wardens, 2 senior wardens and a warden manager; a further three wardens are to be recruited shortly.

The service delivers a single point of resolution for street scene issues, focusing on:

- monitoring waste collection and street cleaning
- acting as custodians of the highway (misuse, damage or obstructions)
- monitoring Medway's parks and green spaces
- encouraging good environmental behaviour by education, enforcement, and promotion
- anti-social behaviour complaints, including fly tipping, abandoned vehicles and dog issues
- enforcement of street trading and hackney carriage legislation
- major emergencies (forward control officer role).

Each warden is responsible for an individual area, which is made up of one or more wards. The wardens have extensive local knowledge and work closely with local councillors and the community (including neighbourhood watches) in their area. They are principally field officers, who spend most of their working day responding to residents' enquiries for service, monitoring the highways and public open spaces and identifying and resolving various issues as they arise. Continuously developing and building on their in-depth knowledge of the area they cover, they act as the 'eyes and ears' of the Council. They normally respond with a face to face visit to complainants, or by telephone. This provides a personal, coordinated response, ensuring continuity of service from the authority.

All the wardens are uniformed and have their own vehicle, mobile phone, radio, laptop computer, camera and safety equipment. The service operates a shift system from 7am until 7pm weekdays and two wardens work from 8am to 5pm to cover weekends.

The warden service works closely with all departments of the Council and other outside agencies, including the police and fire brigade. It has recently completed a two month pilot project with the DVLA. A new joint initiative on one of Medway's high streets will tackle the problems of arson when rubbish is left out before collection is due.

The most important asset the service has is its staff. We are very fortunate indeed, as our staff are committed to the service we provide and work together as an efficient and effective team to achieve a cleaner and safer environment for the residents of Medway. Comprehensive training has been crucial to the success of the service, together with support from other directorates of the Council and the willingness of officers to work with various external agencies.

**Contact:** Carole Brown, Medway Warden Manager, Medway Council, Compass Centre, Chatham Maritime ME4 4YH. Tel: 01634 333047 or email: carole.brown@medway.gov.uk

## Newport CBC Estate Ranger Service

The current role of the Estate Ranger Service (ERS) is “*To protect Council tenants from anti-social behaviour*”; thus the primary objectives of the Service are to identify and stop those responsible for anti-social behaviour, leading to the elimination of anti-social behaviour on Council estates.

The ERS has 18 members of staff (a manager and two admin staff, and 3 teams of one senior and 4 rangers) and operates 365 days of the year from 8.30 am-midnight, with an answering service outside these hours. Rangers wear a low-key uniform and patrol in Council vehicles; they can be diverted to incidents by radio messages sent from a centralised Control Centre which accepts calls from the public. Until recently, the Service was restricted to Council estates – approximately 12,500 properties; it has since widened to include Charter Housing Association estates – a further 1,600 properties, and now covers about 25% of the Borough.

The Service is able to provide a rapid response to calls from tenants and housing staff, as well as carrying out pro-active patrolling on estates to reassure tenants and to deter trouble-makers. The aim of the patrols is to stop anti-social behaviour at the earliest opportunity and with the least amount of fuss. About 90% of tasks are completed at the first point of contact, on the doorstep or on the phone; 97% of tasks are dealt with within one hour of receipt. The Service is therefore extremely responsive and effective in dealing with problems and also in filtering out those tasks that do not need police or further management action.

The ERS is currently dealing with incidents at a rate of approximately 10,000 a year (about 27 a day), an increase of 25% over the previous year. Incidents can be broken down into three main categories:

- **Anti-social behaviour**, which accounts for about 84% of calls. Criminal activity is not dealt with but passed immediately to the police. Issues dealt with by the Service over the past 12 months include vandalism, general nuisance, noise complaints, pet complaints, vehicle offences, neighbour disputes, fly tipping and other environmental issues;

- **Management tasks** account for about 10% of tasks; here the Service acts as the eyes and ears of the Authority during pro-active patrolling and will identify problems such as defective street lights, abandoned vehicles, road repairs etc, as well as housing matters;
- **Security** – about 6% of tasks, including support to staff, lone workers, etc, tenants welfare, security checks on empty properties and identifying criminal activity to report to the police.

The Rangers have no special powers, relying purely on informal persuasion; where this fails, there are a number of legislative options available – e.g. the Housing Act and the Environmental Protection Act – and the case will be referred to the appropriate department of the Authority for further action. The Rangers do not of course deal with any criminal activities, which are referred directly to the police. Of the approximately 10,000 incidents of anti-social behaviour arising each year, about 200 will need to be referred to the police. These include cases where the nuisance is considered deliberate or involves criminal damage or public order offences. A small percentage (1%) will go on to appear in the civil courts.

In conclusion, it is considered that the vast majority of incidents brought to the attention of the ERS are neither malicious nor intentional. Most nuisance is caused by inconsiderate or indifferent neighbours, or youthful high spirits. The perpetrators, once they are made aware of the problem are often surprised and embarrassed and will stop what they are doing and often apologise. Loud music is a typical example. However, the nuisance if left unchecked degrades the quality of life on the estates and gives rise to neighbour disputes than can fester and get out of hand. Nipping the problem in the bud, however, without showing an excessive reaction creates a better atmosphere and raises the quality of life.

**Contact:** Richard Winfield, Estate Ranger Manager, Newport County Borough Council. Tel: 01633 214415.

# Innovation in Sustainable Development

## Bolton's Environmental Strategy 2000-2005

John Eley

Bolton Metropolitan Borough Council

*Bolton Metro was amongst the first local authorities to react to the Earth Summit in 1992. As early as 1994, an Environment Team of nine staff was set up to develop the growing environmental agenda and support the development of an Environmental Forum. In 1997 Bolton's Local Agenda 21 was published and in 1998 a Youth Environment Forum to engage children and young adults was established. Bolton is also part of the Red Rose Community Forest and is an award winning member of the Tidy Britain Group's People & Places Programme.*

The emphasis of the Council's new Environmental Strategy is now to place environmental issues at the heart of the organisation and to improve its own environmental performance.

### Environmental Performance

Bolton Metro employs over 14,000 staff delivering over 140 major services. The organisation spends over £350 million annually and administers a population of 267,000. The local authority has a massive environmental impact through its use of energy and water, the creation of waste, purchasing and transport. A strategic environmental review of the organisation revealed the scale of its environmental impacts.

### Energy

In 1998/99 Bolton Council spent £4 million on energy which generated an estimated 50,000 tonnes of CO<sub>2</sub>. This is equivalent to the carbon stored in over 1,500 acres of mature (55 year old) sitka spruce forest. The Climate Change Levy which came into force in April 2001 will add around £331,000 to the Council's energy bill.

### Water and Waste

Large amounts of water are also used in municipal buildings such as swimming pools and school kitchens. In 1998/99 the Authority used over 366,000 cubic metres of water which cost £425,000. Council buildings also generate around 3,600 tonnes of waste for disposal by landfill or incineration. Much of this waste could be recycled.

### Purchasing

A large slice of the Council budget is spent on the purchase of goods and services. For example, in 1997/98 the Council

spent an estimated £60 million on goods and used 127 million sheets of paper of which only 1.2% was recycled.

### Transport

The Council uses a large number of vehicles to provide its services. Staff travelled some 6.7 million miles on Council business in 1997/98. In addition, some 72% of Council staff travel to work by car. Obviously this has an impact on air quality and traffic congestion.

### Improving Council Performance

Bolton Council's new Environmental Strategy uses a number of tools to enable the organisation to improve its environmental performance. It sets out a number of green housekeeping targets which focus attention on key areas. These targets are included in the Council's Best Value Performance Plan which is audited by the Chief Executive's Department. By 2005 the Council will:

- reduce CO<sub>2</sub> emissions from its buildings and transport use by 20% from 1998/9 levels;
- reduce water and energy consumption in its buildings by 10% from the 1998/9 levels;
- reduce waste generated from its buildings for disposal by 10% from the 1999/2000 levels;
- use environmental criteria when purchasing goods and services;
- establish environmental management in all Council departments;
- provide environmental awareness training for staff;
- publish and report the Council's environmental impacts annually.

Setting measurable targets to improve our environmental performance has enabled Bolton to be the first local authority in the North West to sign up for the Government's new initiative to improve the green performance of organisations: *Making a Corporate Commitment 2 (MACC2)*. Performance under this initiative requires participants to set specific, quantified targets and to report on progress.

### Best Value and Environmental management Systems

Much of the experience utilised in developing the Council's Environmental Strategy was obtained from a pilot environmental management system for part of the local

authority which was accredited to ISO14001. Environmental Management Systems have the benefit of establishing a systematic and auditable method of managing environmental impacts. Accordingly, Bolton Metro has integrated environmental management systems into its best value review guidance. Every best value service review is expected to identify its significant environmental impacts and to ensure that they are being managed to deliver continuous environmental performance. As a minimum, reviews are expected to show how they are helping to achieve the corporate green housekeeping targets.

Of course, local authority services will have a greater variety of environmental impacts than the corporate green housekeeping targets. Each review will have to identify what these are and ensure that they are within management control. To assist review teams, a half day training module on best value and sustainable development is provided by the Local Authority.

### Delivering change

Responsibility for delivering the Environmental Strategy lies with a corporate working group of nominated *Departmental Environmental Champions*. The Champions are senior officers and the group is chaired by a Director who is responsible to the Chief Executive. The Group meets every quarter and is spearheading environmental management in the organisation.

A number of improvements are being achieved:

- Best Value Review Teams are currently being trained on sustainable development and their improvement plans assessed;
- a new Council Energy Strategy has been developed which allows the purchase of green energy and seeks to increase spending on energy conservation;
- a staff Travel Plan which includes green issues is being developed;

- recycling schemes are being developed throughout the Council with an initial focus on paper.

### Tackling Broader Environmental Problems

As well as delivering improved environmental performance of the organisation, the Environmental Strategy sets out the framework for a number of major areas of work which are improving the quality of the Borough. For example, by 2002 the Bolton Environment Forum will have reviewed Bolton's Local Agenda 21 Action Plan.

Bolton has also produced a draft Contaminated Land Strategy and is taking part in a Greater Manchester wide public consultation exercise on air quality management. Progress on tree planting under the Community Forest is going well: over 100 hectares of woodland (250,000 trees) have been planted since 1994. The Council is also working with the Audit Commission to pilot a set of quality of life indicators which will measure progress on sustainable development.

### The Challenge Ahead

The degree to which Bolton Metro improves its environmental performance over the next five years will depend on the continued support of Chief Officers and Elected Members. Much will also depend on the ability of the Best Value process to stimulate change and encourage Council services to incorporate environmental sustainability into their work.

John Eley, Principal Environmental Planner, Bolton Metropolitan Borough Council, Milton House, Wellington Street, Bolton BL3 5DG. Tel: 01204 336655; Fax: 01204 336695; email: [john.eley@bolton.gov.uk](mailto:john.eley@bolton.gov.uk)

# Innovation in Sustainable Development

## Cramlington Organisation for Nature and the Environment

Ann Deary

Blyth Valley Borough Council

*CONE (the Cramlington Organisation for Nature and the Environment) is a public/private sector partnership which encourages wildlife agencies, schools, business, local authorities and the community to take part in projects that benefit the local environment.*

*Established in 1991, CONE's work has played an enormous role in developing an LA21 strategy for Blyth Valley. Crucially, it has also established a network of partners who are now actively involved in LA21. Now in its tenth anniversary year, CONE continues to actively promote urban nature conservation, with events in 2001 including a regional Gardening for Wildlife Project with the Housebuilders Federation and a national 'Be Nice to Nettles Week' as well as many local projects and activities.*

Cramlington, in South East Northumberland, has a national and international business community, and a young and expanding population. The town is a 'new town' with much scope for habitat creation, and plays host to several wildlife corridors. The town has many community groups and organisations and CONE has worked with a great variety of them in promoting biodiversity.

The main aims of the project are:

- to assist in the development of school nature areas;
- to develop the potential of wildlife corridors in Cramlington;
- to provide areas of natural habitat within easy reach of residents (probably a unique aim in a new town);
- to raise awareness of, and interest in, nature conservation.

CONE's role in promoting nature conservation has led to many organisations who would not otherwise have been involved to be brought into the LA21 process. Nature conservation is participative and offers a clear result of which partners can be proud. Once these partners look at the reasons why nature conservation is necessary the natural next step is to investigate all natural resource use.

### Working with Schools

Over the last academic year, CONE has worked with 2711 children in 13 schools (First, Middle and High schools). All of these children were involved in practical nature conservation schemes in their schools or the surrounding area. Over the last nine years, CONE has worked with every school in Cramlington (17 in total). We estimate that CONE

has had around 30,000 interactions with Cramlington children over the last nine years, as well as over 20 industrial partners and numerous community groups.

In schools CONE has worked on providing outdoor classrooms. 28% of a child's time can be spent in the school grounds yet often they can be boring and inhospitable environments. Developing school nature areas can transform the grounds from a biological desert to a living ecosystem which is visually interesting and educationally valuable.

CONE encourages whole school involvement, with parents, teachers, governors and students all working together to design, install and manage school nature areas. Nature areas can be used to support National Curriculum study, not just in Science and Geography but in French, Art and Technology. Since 1995, CONE has employed a Community Education Officer, who works with schools to get the best educational value from their nature areas. The resource can be used to initiate wider topics of citizenship and sustainable development in the National Curriculum. The work CONE has done with schools has led to several favourable mentions in partner schools' OFSTED reports.

CONE also encourages schools to link with all sectors of the local community, and often facilitates projects which take schoolchildren out of their school. This has included a Native American Indian project, a red squirrel day at a local golf club and trips to local industrial partners who have developed nature areas in their grounds.

Industrial partners who have worked with CONE on developing their grounds for wildlife and schools use include BASF, Merck Sharp and Dohme, Bristol Myers Squibb and Cova Products. The latter named has designated an area of its expansion land as a Local Nature Reserve (LNR).

The success of CONE in linking partners and schools has been influential in the Council establishing its own LA21 schools project.

### Planning for Real

Cramlington is a 'new town' nearing the end of its development (for housing). One of the newest estates in the town has recently been involved in a "planning for real" exercise to enable the local community to set priorities for spending a considerable Development Fund budget. One of those priorities was the enhancement of a local stream. CONE is involved with guiding the work, providing advice and practical help to the community, and taking part in activity days of planting and community clean ups.

Annually, CONE is involved in several community clean ups, especially during the National Spring Clean. This work has included providing guidance and practical help to a ten year old eco warrior as well as many community groups.

### Wildlife Beer Festival

Since 1999, CONE has worked with a local pub to theme their annual Beer Festival. The result has been the 'Wildlife Beer Fest'. Twelve beers are chosen which have a wildlife-link. This link is then explained further on specialised 'beer mats' given to customers with each purchase. In 2000, the Wildlife Beer Festival attracted over 1,000 people and gave CONE valuable contact with people who would otherwise have been unreachable.

### Resources and Partners

CONE also seeks to produce leaflets and resources for schools. Working with English Nature, CONE has produced several leaflets which have been a national success. The literature produced aims to educate in a simple and fun way. Each leaflet folds out into a 'visual key' which can be used for field work, although the leaflets have also been used for the Literacy Hour. One thousand copies of the first leaflet, on butterflies, have been sent to locations all over the UK.

Partners in CONE are:

BASF Plc

Blyth Valley Borough Council

Bristol Myers Squibb

Cova Products

Dana Cramlington Precision Forge

English Nature

Fasson UK

Merck Sharpe and Dohme

Northumberland County Council

Northumberland Wildlife Trust

Northumbrian Water

RSPB

For further information on CONE please contact Phil Castiaux, Project Co-ordinator or Ann Deary, Project Manager, on 01670 542384. Email [cone@blythvalley.gov.uk](mailto:cone@blythvalley.gov.uk).

# Obituary

## ALLAN H BROWN

Allan Brown, who died on 8 February 2001, was a longstanding member of the East Midlands Division of the NSCA and of the Council of the Society.

Allan Brown was a Chartered Chemist and after working in the rubber and chemical industries in the London area joined HM Alkali Inspectorate in 1959 following expansion of duties under the Alkali Works legislation of that year. The legislation was directed at those industries which produced smoke and SO<sub>2</sub> and complemented the Clean Air Act.

Allan spent 12 years in the SW of England gaining experience in regulating a variety of industries and in 1971 was appointed as District Inspector based in Lincoln and covering the counties of Lincs, Notts, Leics and later Humberside.

He became well known to the industries he helped regulate and personified the concept of fair but firm regulation. He was dedicated to the cause of air pollution control and it was during this period he joined the East Midlands Division of the National Society for Clean Air. He was Chairman of the East Midlands Division during 1994/95 and a member of the National Council. Allan was also a keen and active trade unionist being Vice Chairman of the Inspectorate branch of IPCS (now IPMS) for many years. Allan remained in Lincoln for the rest of his career transferring to HM Inspectorate of Pollution in 1987 when that body was formed. He was promoted to Superintending Inspector in his last year.

He retired in 1990 and was active for some time with his own consultancy. The highlight of this work was 2/3 weeks dealing with a steel works in Mexico.

Allan Brown will be sadly missed by the East Midlands Division, particularly for his work on the Society's former Technical Committee, and more recently as a member of the Air Quality Committee and Local Environment Management Forum. We offer our deepest sympathy to his family.







# ***NSCA Events for 2001-2002***

Tuesday 12 June

*Training Seminar, NEC Birmingham*

**Telecoms, Masts and Power Lines - health and planning issues for LAs**

Wednesday 20 June

*Conference, RSA, London WC2*

**Public Acceptability of Incineration**

Wednesday 27 June

*Conference, RSA, London WC2*

**Industry and the Environment**

Tuesday 18 September

*Training Seminar, NEC Birmingham*

**Noise Update 2001**

Monday 22, Tuesday 23 and Wednesday 24 October

*Bournemouth International Centre*

**Environmental Protection 2001, Annual Conference and Exhibition**

Tuesday 13 November

*Training Seminar, NEC Birmingham*

**Contaminated Land**

Thursday 22 November

*Workshop, Chadwick Court, London SE1*

**Dispersion Modelling**

Tuesday 12 February 2002

*Training Seminar, NEC Birmingham*

Wednesday 3 and Thursday 4 April 2002

*Spring Workshop, Abingdon*

*For copies of event brochures please contact:*

**NSCA**

44 Grand Parade, Brighton BN2 2QA

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# *clean air* *and environmental protection*

*Autumn 2001*

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- *Contaminated Land*
- *Stack Height Determination*

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## ***NOISE UPDATE 2001***

**Tuesday 18 September 2001 - NEC Birmingham**

*The annual NSCA national training seminar specifically designed to update noise control officers and other specialists on noise policy and practice.*

*This year the seminar will cover:*

- ***Noise Policy Overview***
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**If your responsibility is noise, this is the one training seminar you can't afford to miss!**

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## **Contaminated Land**

**Local Authority Guide to the Implementation of Part IIA  
of the Environmental Protection Act 1990**

*A series of ten 2 day training workshops for Local Authority officers who are responsible for the implementation of Part IIA.*

*The workshops are supported by LGA, DEFRA, CIEH & EA and are managed by NSCA.*

*The venues and dates are:*

<b>London 1</b>	Thursday 13 and Friday 14 September
<b>Birmingham 1</b>	Thursday 20 and Friday 21 September
<b>Newcastle</b>	Monday 1 and Tuesday 2 October
<b>Southampton</b>	Tuesday 9 and Wednesday 10 October
<b>Manchester</b>	Wednesday 31 October and Thursday 1 November
<b>Exeter</b>	Tuesday 6 and Wednesday 7 November
<b>Birmingham 2</b>	Wednesday 14 and Thursday 15 November
<b>Leeds</b>	Monday 19 and Tuesday 20 November
<b>Bristol</b>	Wednesday 28 and Thursday 29 November
<b>London 2</b>	Tuesday 4 and Wednesday 5 December

**For a copy of the comprehensive brochure giving full details please contact  
NSCA, 44 Grand Parade, Brighton BN2 9QA**

**Tel: 01273 878770 Fax: 01273 606626 Email: [sales@nsca.org.uk](mailto:sales@nsca.org.uk)**

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*NSCA's membership is largely made up of organisations with a direct involvement in environmental protection: industry, local authorities, universities and colleges, professional institutions, environmental consultancies and regulatory agencies. Individual membership is also available to environmental specialists within industry, local authorities, central government, technical, academic and institutional bodies.*

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# Editorial

## WHERE THERE WAS BRASS...

Autumn already? Summer, it seems, has now passed and with it the deadline for English local authorities to produce contaminated land inspection strategies (Scottish authorities have a little longer and the regulations are not in place for Wales and Northern Ireland). However, in the same way that Review and Assessment was only the first step in the Local Air Quality Management process, so inspection strategies mark the opening salvos in a greatly expanded battle for the identification, remediation and redevelopment of brownfield land, bringing it back into usefulness to reinvigorate our urban centres.

Or so the theory goes. If brownfield land is to be redeveloped, we will need, among other things, to successfully assess and communicate the risks associated with living and working on previously used sites. David Rudland of Halcrow Group explores the concept of risk and how it could be properly communicated, while Joanne Kwan, of CIRIA, looks at some of the training material necessary for the assessment of risk.

Local authorities are not, of course, the only people involved in contaminated land, and we will need close collaboration between enforcement agencies, end users, and site owners to cope with the trials and tribulations which remediation inevitably throws up. In our third article, Dr. Richard Busby sets out Powergen's response to contaminated land regulation and discusses its strategic approach based on the development of just such a relationship. From a regulator's perspective, Paula Woolgar from SEPA discusses the licensing of contaminated land remediation schemes. As for the law, Griff Dixon of the Royal Institution of Chartered Surveyors casts an eye over the murky waters of the legal framework to see what the future has in store.

Turning to more practical matters, CL:AIRE (Contaminated Land: Applications In Real Environments) has been responsible for bringing forward some innovative remediation techniques, and some of their current projects are reviewed here. Joanne Kwan also discusses some case studies, this time in bio-remediation, an area which has promised much in recent years. However, before remediation takes place, an assessment of the environmental harm the site is causing needs to be carried out, and Paula Woolgar discussed a method for doing this in the case of designated terrestrial ecosystems.

And finally, Yasmin Vawda and her colleagues at Stanger Science and Environment describe their supplementary technical assistance on stack height determination, produced at the request of DEFRA.

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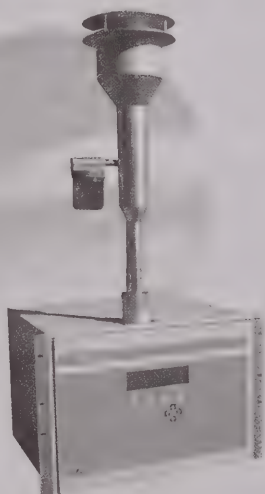
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# Contaminated Land

## What Does It Mean To Me? Communicating Contaminated Land Risks

David Rudland

Halcrow Group Ltd

*We are all exposed to hazardous substances in our daily lives. This is inevitable, whether by vehicle fumes, household cleaning products or occupational exposure. However, place the words "hazard", "contamination" and "exposure" in one sentence and this can instantly create a very negative perception of the condition of a particular piece of land. It is not uncommon for people interested in the land to become alarmed even if the substances on the land are similar to those in common everyday use. This article is about the way in which contamination risks can be communicated to those who need to know.*

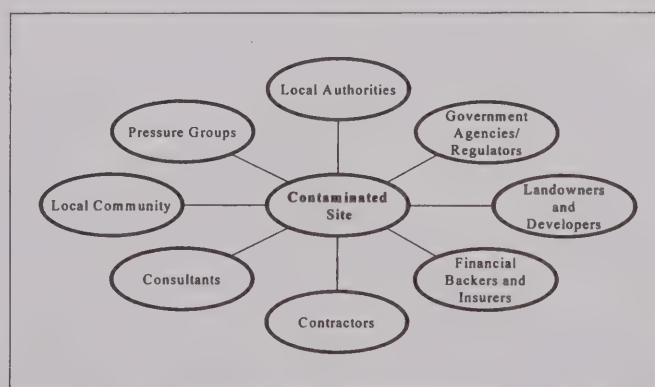
New contaminated land legislation that has come into force in England and Scotland requires local authorities to go actively looking for land contamination on a scale as never before. Prioritisations, risk assessments and remediation of land will become more commonplace as experience with the legislation develops. A thorough assessment of risk that any contamination present on land might be posing is the precursor to any action that might be taken to put the site "back into beneficial use". That assessment is usually made on a technical basis, but how are the results of that assessment communicated to those who need to know, and who are these people anyway?

The process of communication of risks is something that is frequently forgotten, in the scramble to manage contamination at a site, quite often with devastating consequences. Consider this story:

*A former tip was landscaped to become a park with full public access. Some years after the park was opened highly coloured substances began to appear on some of the landscaped areas. A preliminary study of the site identified that drums of chemical waste had been dumped there some thirty years previously, whilst the tip was still operational. The park's owners decided to carry out investigations to determine the nature and origin of the discoloration. There was no immediate indication of what the chemical nature of the discoloration might be, so the contractor employed to carry out the investigation prepared a health and safety plan for its staff that identified the need for protective clothing to be worn during the site works. The works duly commenced, on a day when the park was fully open, so that*

*the investigation staff mingled with the users of the park. Many regular users of the park became aware of contamination issues for the first time when they saw scientists amongst them taking samples of soil and groundwater wearing white contamination protection suits and breathing apparatus. This prompted a flurry of speculation, particularly in the local media, and enquiries to local authority officers, regulators and local representatives from park users and local residents expressing fears about potential hazards to health. Very soon, use of the park became minimal.*

Quite simply, no-one considered the effect that the risk assessment process might have on the wider community. As a result the beleaguered local authority's environmental health officers' phones went into meltdown, even though these officers had had no prior warning of the investigation themselves. Too often, technical risks are debated by technical people, who then implement or recommend technical solutions. But it is not just technical people who need to make decisions about contamination; other individuals and groups may have an interest in a particular site and need to understand the situation and decide what it means to them. Consider all these different stakeholder groups:



Would you expect all these to have the same concerns and understanding about the frequently complex technical issues surrounding contaminated ground?

*"Issues surrounding contaminated land are perceived as being complex; they certainly require the involvement of specialists or "experts". But this does not place matters beyond the ability of most people to follow and understand most of the issues involved" (Friends of the Earth, ref. 1).*

The story, above, of the park illustrates the different view of risk taken by different stakeholders. The owners of the park saw the risk as a technical matter to be resolved following technical procedures (beginning with sampling and testing) and the contractor seeing this as a health and safety issue (in terms of protective clothing). On the other hand some local residents and park users considered the risks associated with living near and using it were unacceptable.

So how can situations such as this be avoided, and how should contaminated land risks be communicated?

Well, non-communication isn't an option. No communication sends a message of complete disregard!

- **Poor communication** leads to misunderstandings, inappropriate decision making, and disenfranchisement of one or other party.
- **Good communication** encourages discussions between the various stakeholders to help reach a common understanding of the situation and selection of the way forward most acceptable to all.

Briefly, there are four stages involved in communicating risks (ref. 2).

#### 1. Determine who to communicate with

Make sure that you identify your interested stakeholders. It is important not to leave anyone out. Whereas it is easy to identify institutional bodies such as landowners and funding organisations it is less easy to identify private individuals with an interest. Many may not actually live close to the site.

#### 2. Choose the time to communicate risk

The example above illustrates that timing of the communication is crucial. The temptation is to leave communication to the end of the risk assessment process, but by then the risk assessors may have reached conclusions without any input from other stakeholders. There is no opportunity for the assessment process itself to be challenged and modified to address others concerns. The assessment is seen as a closed package.

#### 3. Decide what to communicate

This involves a difficult balance, because at early stages of the risk assessment process, you might not have too much to communicate. It is best to be as open or honest as possible about what is being communicated. Being reluctant to communicate can lead to accusations of holding back information. Be prepared to admit there are uncertainties surrounding technical knowledge of what is actually going on at a site, and therefore that there is room for differing interpretation.

#### 4. Decide how to communicate

This is about the manner and circumstances in which the message about risk is delivered. Communication is a two way process, otherwise it becomes a lecture. The receiving party understandably hears that the outcome is a foregone conclusion, that their opinions do not matter and that they have no influence on what happens next. Disillusionment and resentment may rapidly set in.

It is often the case that where questions arise about land contamination locally, it is the environmental health and planning officers of the local authority who receive queries from the public even when they have no knowledge of the land concerned. This is especially the case where development encounters contamination. In this circumstance local authorities might consider co-operating with the developer to jointly communicate progress with dealing with land contamination to interested parties. In one case in Cheshire (ref. 3), the authority worked with the developer by:

- establishing a Residents Consultation Group
- acting as a liaison point between the Environment Agency and Health & Safety Executive
- providing a guarantee of rapid response to queries – a key point of contact within the local authority was identified
- ensuring monitoring of off site effects was carried out by an independent consultant.

The authority reports the positive outcomes of this process as:

- publication of reports and newsletters for all
- the Residents Group were broadly satisfied along with the majority of the local community
- new working relationships were created
- the attitude "why does the site need cleaning" became "we accept it needs cleaning".

This kind of approach, whilst not bringing about unanimous opinion of what represents an acceptable solution to land contamination, can encourage discussion and stimulate most to seek a workable solution to the situation. Of course, there will be dissenters, because there will be different agendas that will conflict, and frequently concerns are based on property value rather than health. It illustrates the fundamental principle that successful risk communication requires the involvement of all stakeholders in the decision making process.

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David Rudland is a senior contaminated land specialist with Halcrow Group Ltd, in Swindon. This paper is derived from research carried out on behalf of CIRIA for its recent publication C552 "Contaminated Land Risk Assessment – a guide to good practice", of which he is co-author.

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# Risk Assessment and Remediation of Contaminated Land Training Material

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Nicki Nesbit, Enviros Aspinwall

*Key words: education and training, knowledge transfer, contaminated land, risk assessment, remediation*

Redevelopment of contaminated land is a substantial business in this country. Over £500 million is spent every year in the UK on removing contaminants from polluted sites. Part IIA of the Environmental Protection Act 1990, which was implemented in England and Scotland more than 12 months ago, has brought new responsibilities to many construction practitioners.

Recent research carried out by the Construction Industry Research and Information Association (CIRIA) shows that while a large number of construction companies have more than ten years experience in dealing with contaminated land, more than half of their staff are not receiving training on the subject.

Training is needed for consultants, contractors, regulators and other construction professionals, involved in contaminated land schemes, particularly in the following areas:

- the development of objectives for risk assessment
- data collection processes including site investigation and estimating the risks of the site
- identification of contaminated land-related, engineering and management objectives, based on the risk assessment, site specific constraints and legislative requirements
- the development of the remedial strategy
- selection and implementation of the appropriate remediation options including monitoring and aftercare operations.

## Background

The UK construction industry is under growing pressure to build on contaminated land. The government has set targets for increasing the amount of building on previously used sites over the next ten years. Where contamination exists, there are often significant problems to overcome before the land can be redeveloped.

There are also significant changes underway in the legislative regime in the UK. New legislation is in the process of enactment that will significantly change the way in which contaminated land redevelopment projects are carried out in this country. A key piece of legislation is Part

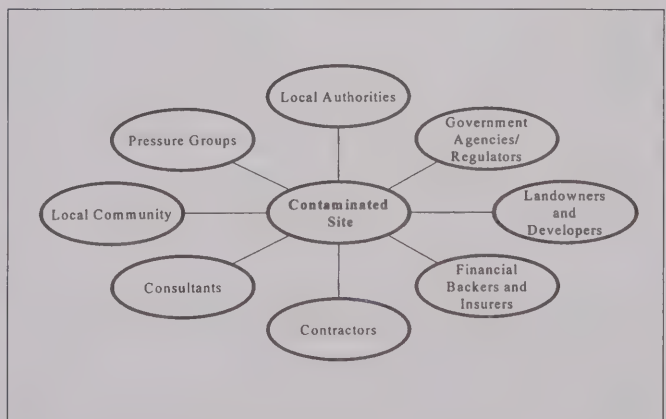
IIA of the Environmental Protection Act 1990 which came into force in England and Scotland in 2000.

Whilst many of those to whom responsibility for carrying forward the new regime will be well versed in the procedures and practices on risk assessment and remediation, many will be facing the responsibility for the first time. In particular, local authorities will have the initial responsibility to conduct or instruct assessments for the new regime; however, as the regime develops, others will need to have the skills necessary to measure the risk and remove contamination from land. This includes professionals from a wide range of backgrounds (Figure 1).

The Construction Industry Research and Information Association (CIRIA) has carried out a research project to assess the need for training materials for those who:

- have an interest in or specify contaminated land risk management (*Clients*)
- practise contaminated land risk management (*Practitioners*)
- regulate contaminated land (*Regulators*).

**Figure 1.** Contaminated Land Stakeholders



A survey was undertaken using a three-stage approach: a questionnaire, telephone interviews and face to face meetings. The questionnaire was sent to over 320 selected companies, organisations and individuals covering the following groups:

- developers, legal, financial and landowners (*Clients*)
- consultants (*Practitioners*)
- local authorities and environment agencies (*Clients, Practitioners and Regulators*).

The survey showed that:

- 83% of companies procure services in contaminated land risk assessment and the average length of experience is 12 years.
- 50% of respondents commented that their company does provide training which was reported as a mixture of in-house training, conference attendance and external courses.

This does tend to suggest that whereas many companies might provide services in contaminated land management, and some for many years, training is not always available.

In response to this, CIRIA has commissioned two training packs:

- CIRIA Project RP599 Contaminated Land Risk Assessment – Good Practice Guidance
- CIRIA Project RP601 Remedial Options in Contaminated Land.

The training packs aim to provide sufficient information to allow the user to assess risks due to contaminated land and determine remedial requirements in a rigorous, logical and transparent framework according to recognised good practice at the time of publication. The packs are most suited to those whose duties have recently required them to become involved in different stages of a contaminated land project from other technical fields or who have some knowledge and experience and wish to refine their skills. The packs will also be of benefit to those with experience and who wish to be able to update their abilities in relation to the rapidly changing regulatory regime. The material is primarily intended to be used in a group learning environment, but may also benefit individuals working on their own. In addition, CIRIA has published a third pack, *Environmental Good Practice on Site*, which describes the issues that should be addressed, including contaminated land, during construction activities. A feature of these CIRIA training materials is that they provide signposts to existing documents that describe in detail particular aspects of contaminated land management. The users may wish to conduct further studies of their own and each pack will provide directions to sources of information.

These training packs are now available from CIRIA.

## What Will Be in the Training Materials?

### Risk Assessment

The materials will describe the process by which risk assessment is conducted. The guidance is mindful of the forthcoming *Handbook of Model Procedures for the Management of Contaminated Land*, CLR11 to be published by the Department for Environment, Food and Rural Affairs. The regulatory regime for the assessment of existing contamination is based on the source-pathway-receptor principle. There are four sub-steps involved in this:

- Hazard Identification
- Hazard Assessment
- Risk Estimation
- Risk Evaluation.

Each step involves progressive refinement of data. Hazard Identification and Assessment are the initial data gathering and review stages, more commonly known in the industry as "Phase 1". At this stage the desk studies are undertaken, site history and potential for contamination identified, and the preliminary conceptual model to represent potential sources, receptors and the pathways between them, is proposed.

At the Risk Estimation stage detailed ground investigations may be undertaken in order to confirm the presence of contamination and to allow estimation of the risks that could be expected under defined conditions of exposure. At the Risk Evaluation stage the information is reviewed to decide whether the estimated risks are unacceptable, allowing for any technical uncertainties and other site-specific circumstances. Risk Estimation and Evaluation usually form the stage of assessment known as Phase 2.

Not every risk assessment will need to complete all these stages. It is quite acceptable for the process to be complete at the end of the Hazard Assessment stage if, for example, it has been decided that there are no feasible complete source-pathway-receptor linkages. What is essential for each and every assessment is a transparent decision making process that allows clear concise communication of the risks at each and every stage. Risk communication is a somewhat neglected art and the guidance will discuss this. The result of the risk assessment must always indicate whether the risks associated with the site are acceptable and whether some form of remedial action is required to reduce risks to insignificant levels. This will form the basis upon which the remedial strategy is determined.

### Remedial Treatment

The material will describe the different stages in the selection of the appropriate remedial options for contaminated sites.

#### 1. Setting of objectives

Remedial action objectives can be:

- contamination-related
- engineering
- management.

Contamination-related objectives should take priority in determining the type of remedial action to be undertaken. Remediation, however, will also be influenced by factors other than those arising from the assessment of risks from contamination. These factors include engineering objectives, such as improved stability or ground bearing capacity, and management objectives, such as costs or timescale.

After taking into account site specific constraints such as the physical condition of the site, site use, etc, the remedial action objectives should be prioritised into Primary Objectives (those which must be met) and Secondary Objectives (those which would be desirable to meet). Potential conflicts of these objectives should be resolved early in the project.

2. Review of remediation techniques

A number of remediation techniques are now available and they can be categorised according to the mediums and the contaminants present (Figures 2 to 4). These can be used singularly or in combination to destroy or modify the nature and behaviour of contaminants.

Figure 2. Remedial Options for Contaminated Gases

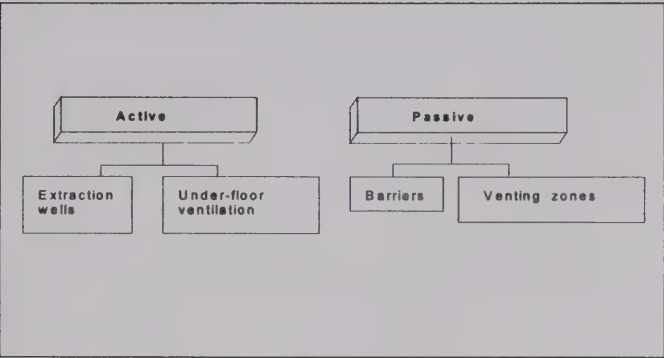


Figure 3. Remedial Options for Contaminated Liquids

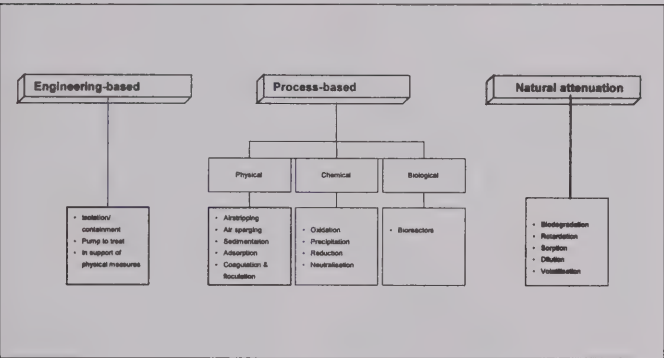
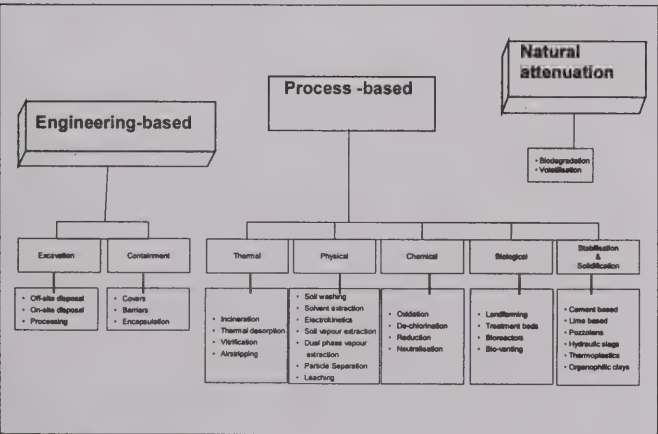


Figure 4. Remedial Options for Contaminated Soil



3. Development of Remediation Strategy

After reviewing the different remedial techniques, it is important to develop a strategy for different zones of the site. The division of zones can be done by depth profile or by lateral profile, media or the suitability of different areas of the site for treatment.

There are a large number of factors that should be considered in the development of strategy (Table 1). It is also

important to consider the impact of remediation in one zone or on one pollutant's linkage to another.

Table 1. Factors that should be considered in Remedial Strategy Development

• Applicability	• Information requirements
• Effectiveness	• Planning and management needs
• Limitations	• Monitoring needs
• Cost	• Health and safety aspects
• Development status	• Potential environmental impacts
• Availability	• Validation requirements
• Operation requirements	• Post-treatment management needs
• Regulatory requirements	• Local concerns

During the development of the strategy, it is important to consult the following third parties:

- regulators, particularly about the application of the relevant consents
- developers
- investors/lenders
- insurers
- site neighbours.

4. Selection and Implementation of Remedial Treatment

Initial selection of the remediation options  
In order to select an initial range of options for different zones, overall objectives should be referred to and the options should be compared against the Primary Objectives. This will result in a list of options for each zone. When appropriate, options for different zones should be combined to form alternative site-wide remedial strategies.

Final selection of the remedial options  
The shortlist of strategies for each zone should undergo further detailed assessment. This will involve further evaluation and screening on technical and environmental grounds. Information such as accurate costings and treatability data will be needed.

A final evaluation should be made against Primary and Secondary Objectives before the final option is chosen for each zone.

Implementation  
Validation including a validation report is an essential part of the implementation of any remedial scheme. In the majority of cases it will be needed to demonstrate that the remedial objectives of the project have been met. It may take the form of analysis to confirm that residual contaminant concentrations are less than the required remedial objective, or that containment measures are performing as planned.

Monitoring is also important both during and after treatment. This may include noise, dust, groundwater, surface waters and gas.

The authors and CIRIA wish to acknowledge the work of all those involved in CIRIA research project 601, Remedial treatment for contaminated land: in-house training material

and 599 Contaminated land risk assessment – good practice guidance, and the funding from the Partners in Innovation Programme of the Department of the Environment, Transport and the Regions (now Department for Environment, Food and Rural Affairs), the Environment Agency, SNIFFER, NHBC, English Partnerships and CIRIA Core member organisations, without which none of the work could have been done.

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## Powergen and Part IIA

### A Private Sector Approach to Contaminated Land Regulation

Dr. Richard Busby

Power Technology Centre, Powergen UK plc

*The implementation of Part IIA of the Environmental Protection Act 1990 has brought the issue of land contamination to the fore. Over the past year, local authorities and the Environment Agency have been preparing for their new duties. The UK's major industrial landowners have therefore taken a keen interest in developments.*

*As one of the UK's leading integrated electricity and gas companies, Powergen has land holdings throughout England and Wales. The company uses land for a variety of industrial applications, including electricity generation in power stations and the distribution of electricity via substations. Sites may have inherited contamination from previous industrial uses prior to acquisition by Powergen. The introduction of the first specific pollution control legislation governing the condition of land is therefore an area of considerable interest to the company.*

*The Contaminated Land Regulations 2000 and associated guidance provide a common framework and language for regulators and landowners to begin a dialogue on the issue. Powergen has an established environmental management system which already incorporates the need to manage land with sensitivity. The new regulations require the company to review its policy and management systems as part of its commitment to continual improvement.*

#### A Strategic Approach

Powergen has taken the same approach as local authorities in adopting its own contaminated land inspection strategy. The task of inspection can seem daunting to a private company with a large number of disparate sites throughout the country or to a local authority investigating a city, district or borough.

The Powergen strategy is firstly to consider the risks associated with each of its sites by carrying out a desk study. This will be followed by targeted intrusive investigations where issues of potential concern have been identified. There are a wide variety of sites in the company's property portfolio, ranging from 1960's coal-fired power stations to warehouses, call centres and company headquarters. Powergen also owns a variety of disused sites, many of which now house valuable nature reserves. A risk assessment approach is the only way to compare such a wide range of property types in a manner that will generate priorities for investigation and action.

Adopting a strategy allows local authority officers to spread ownership of their new duty to their elected members and seek resources to fund the investigation. Similarly for a private company, a strategic approach encourages "management buy-in". This helps secure resources, both in terms of staff time and financial commitment, for a staged investigative process.

Local authority strategies have had an important role to play in the development of the Powergen strategy. The private sector's priorities must reflect those of local authorities if progress is to be made in dealing with problem sites. The clear statements of intention required in the local authority strategies will assist landowners to engage with the regulators with mutual understanding.

#### Implementing and Investigating

Our strategy will ensure that all Powergen sites (both operational and non-operational) will be reviewed as part of the initial investigations. Contact will be made with all relevant sites. "Management buy-in" is essential so that managers can commit time to talk to the investigators and provide supporting information. The questions posed are:

- ♦ *What do we know about the sites?*
  - Documented information such as borehole records, construction details, site investigation records.
- ♦ *What do we think we know about the sites?*
  - Investigators must be able to deal with anecdotal information that is not backed up by records, and decide whether to take this forward.
- ♦ *Where are the gaps in our knowledge?*
  - This varies from site to site. Operational sites hold detailed information on the smallest amount of chemical stored on site. However, if sites have been mothballed and are awaiting sale, gathering detailed information about past activities requires much more time and resources.

All relevant sites already have a Land Management Plan as a requirement of Powergen's Environmental Management System. However, these plans provide only some of the information needed to carry out a robust contaminated land risk assessment and prioritisation exercise. Further research is needed to supplement this information for some of our sites. Even more effort is required to research holdings where there are no current land management plans, such as the mothballed sites.

Information management has also been a critical part of the investigation process. The recommended criteria for desk studies laid out in CIRIA Special Publication 103<sup>1</sup> has proven to be the best way of standardising the information gathered from various sources.

## Working with Local Authorities

Powergen deals with environmental regulation on a day-to-day basis. The company has worked hard over many years to establish good relationships with the Environment Agency inspectors who authorise and inspect its operations. However, local authorities are the lead regulators for the contaminated land regime and have set their own priorities for inspection within their areas. Working with a new set of regulators requires an investment on Powergen's part to establish good relations.

A total of sixty-three different local authorities are responsible for inspecting districts in which Powergen has a presence, each with its own local priorities. Nine local authorities are responsible for inspecting districts where the company has its operational power stations. Another six local authorities will be investigating the districts where Powergen has its offices, warehouses, and depots. The company's distribution arm, East Midlands Electricity, has land holdings throughout a further forty-eight districts.

If problems are identified on one of the operational sites within the boundaries of an IPC authorised process, the local authority will pass the regulatory duty to the Environment Agency by declaring it a "special site". However, it is common for the company to own land beyond the boundary of the IPC authorised site, and regulatory responsibility for this will remain with local authorities.

The prospect of building relationships with so many different regulators is daunting. Fortunately, the

contaminated land inspection strategies being prepared by local authorities provide a helpful starting point to begin engagement. The open and transparent manner in which these strategies are being prepared and the clear statements of intent given are positive steps in establishing a dialogue with responsible landowners.

However, from a telephone survey conducted in June and July 2001, it is clear that some local authorities have only been able to direct a limited amount of time and effort towards this new duty. While most will have finalised their documents over the summer, some have struggled to meet the 1 July deadline because of other statutory duties. It is vitally important that this new regime is consistently enforced throughout the country. Local authorities must also be able to properly resource this new duty if responsible landowners are to feel confident they are dealing with trained and experienced regulators.

## Conclusions

Powergen is a private sector company which places great value on its environmental performance. The company is dedicating substantial resources to investigating the state of its land holdings throughout England and Wales in response to the implementation of Part IIA. A desk study of the company's main land holdings is nearing completion. The findings of this exercise will be used to determine where further investigations may be required, leading to a costed programme of priority actions.

A key goal of Powergen's strategic approach is to engage with local authorities and the Environment Agency. The development of good working relationships will ensure that contaminated land issues are dealt with swiftly and effectively, with the private and public sectors working together towards their common goal of sustainable development.

## References

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## Licensing the Remediation of Contaminated Land in Scotland

Paula Woolgar

Scottish Environment Protection Agency

*It is a common misconception that remediation can only result in an environmental improvement. The remediation of chemically contaminated land and associated groundwaters, whilst carried out with the intent to improve their condition, has the potential to adversely impact on the environment whilst remedial work is being undertaken. Adverse impacts can be associated with the removal of contaminated soil if dusts are generated, and with the treatment of contaminated soil and groundwater, if releases of contaminants are made to water, land and air. Furthermore, remedial work can result in the mobilisation of contaminants to air and water or the dispersion of contaminated materials across a wide area.*

In order to ensure that remediation does actually result in an environmental improvement, it is essential that such impacts are controlled. This is normally achieved through implementation of an appropriately designed remediation scheme and the application of legislative control. The controls applicable to remediation activity relate to waste management, water pollution and air pollution legislation:

the extent and standard of remediation may be subject to separate regulatory control, for example under Planning Control or Part IIA of the Environmental Protection Act 1990. Waste management controls only apply when the holder discards, intends to discard or is required to discard contaminants in soil. Contaminants are typically discarded by treatment or disposal and as they are normally dissipated within soil, the contaminated soil itself becomes waste.

The legislative controls that apply to contaminated land remediation activity and for which the Scottish Environment Protection Agency (SEPA) is the regulatory authority, are summarised in the Table below. Some of the controls require those implementing a remediation scheme to apply for various licences or consents, and as applications for these may take up to four months to issue, it is important that this is allowed for in any remediation project plan. The controls vary according to each remediation scheme and it is important that the licensing requirements of specific schemes are discussed at an early stage with the local SEPA office.

Activity	Legislative control	Action
Treatment of waste soil in- or ex-situ	A waste management (WM) licence is required for the waste treatment activity (mobile plant or site licence). A site licence only applies to the actual site licensed and may cover the treatment, disposal or keeping of waste or any combination of these. The conditions applied and surrender provisions will vary depending on the licensed activity. A mobile plant licence applies to whatever site the plant is used at, subject to preparation of a working plan for each site at which it is operated. Waste treatment activity includes the stabilisation, vapour extraction, washing and bioremediation of waste soils.	Ensure contractor has a mobile plant licence and an approved working plan for the site  OR Apply for a site licence
Disposal of waste matter on-site	Waste soil and other wastes which are excavated and disposed of on-site are subject to waste disposal licensing requirements and require a site licence.	Apply for site licence
Disposal of waste matter off-site	Waste soil or other waste which is removed and disposed of off-site is subject to the duty of care requirements and should be taken to an appropriately licensed site.	Ensure meet duty of care requirements
Treatment and/or disposal of contaminated groundwater*	The treatment of waste water or the disposal of liquid waste requires consent under the Control of Pollution Act 1974 (COPA) unless a waste management (site) licence is held. Treatment is normally encompassed within disposal and so there is generally no requirement for site licence if a COPA consent is held.	Apply for COPA consent

Activity	Legislative control	Action
Discharge to controlled waters*	Where remedial works result in a discharge to controlled waters, a consent under COPA should be obtained by the operator as a defence to any offence under section 30F. It is an offence under COPA to cause or knowingly permit any trade effluent, poisonous, noxious or polluting matter or any solid waste matter to enter controlled waters, unless consented under section 34 of the Act or otherwise licensed or authorised. Controlled waters includes inland, coastal and ground waters. Discharges may include the discharge of treated water or the introduction of oxygenating chemicals into water.	Apply for COPA consent
Discharge to land	Consent under COPA is not required as a prerequisite to commencing a discharge of trade effluent to land. However, SEPA has powers to serve a prohibition notice should control be required. A prohibition notice may be absolute (requiring the discharger to apply for consent if he wishes to make the discharge) or conditional. Where discharge is made of matter which does not represent trade effluent and which contains substances listed under the Groundwater Directive, control may be required under the Groundwater Regulations 1998.	Notify SEPA
Installation of barriers	The installation of cut-off walls and barriers normally falls outwith waste management licensing requirements, unless contaminants are being discarded through treatment or disposal. Where barriers are formed through pumping of grout or injection of clays containing listed substances into soils, this may constitute an activity subject to the requirements of the Groundwater Regulations 1998.	Notify SEPA
Crushing and screening	The crushing and screening of soil is likely to require authorisation under Part I EPA unless the activity is covered by a waste management licence.	WM licence OR Authorisation
The incineration of soil	The incineration of soil represents a prescribed process and is subject to control under Part I of Environmental Protection Act 1990. If the plant treats less than 1 tonne per hour of waste soil an hour, it will be licensed as a Part B process and if it treats more than 1 tonne per hour, it will require an IPC authorisation.	Ensure contractor has authorisation OR Apply for authorisation

\* In England and Wales, Consents to Discharge are given under the Water Resources Act 1991.

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## Contaminated Land Law - the Next Stage

Griff Dixon FRICS

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*We are at an interesting stage in development of the contaminated land laws. In particular the long gestation period of the Statutory Contaminated Land Regime could soon be at an end. Local authorities in England were due to publish their strategic plans by the end of June 2001 (later in the rest of the UK). Following the publishing of those strategic plans, regulation under the Statutory Contaminated Land Regime should become visible. I consciously use the words "regulation" and "visible" for two reasons. The first is that whilst there has been little regulation to date by local authorities and the Agencies under the Statutory Contaminated Land Regime, the principles behind the regime have nonetheless been applied for several years in transactions and land developments. The second reason is that some regulation has already begun but the visibility of that regulation is not great.*

With regard to the regulation that has already commenced there have been faltering first steps by the regulating officers at the sharp end. This is not surprising. Despite all the internal training of the local authorities and Agencies, and the development of operational manuals and procedures, there will be a high degree of "learning by doing" (indeed many of the officers will openly say this). Similarly commercial organisations embroiled in the regime are feeling their way to a large extent. The more proactive (and exposed) organisations are already conducting risk management exercises in relation to their existing and former property holdings, an objective being to analyse the risks and, if necessary, put themselves in a state of preparedness should regulatory action commence against them.

Subject to a few notable exceptions (especially the Cambridge Water (1993), Blue Circle (1998) and Mott McDonald (1998) cases), there has been little significant case law on contaminated land. That is not to say that contaminated land laws are largely theoretical (as vendors often try to argue). In terms of legal practice there has been considerable development over the last decade, and most particularly in the last 5 years. Indeed, 5-10 years ago there were difficulties persuading many clients and transactional lawyers to take contaminated land risks seriously. Nowadays clients are more likely to raise the issue and demand legal service in relation to environmental risks. In those early days express environment law provisions in contracts were virtually non-existent. Environment lawyers had to invent the most basic contractual provisions, such as enquiries, warranties and indemnities (and truly fanciful were some of the early provisions). Nowadays most law firms and organisations such as the Law Society and the local authorities have standardised documentation. This does not, however, do away with argument. The client's

lawyer will of course continue to argue in his client's interest, but the path is now as well trodden that the better lawyers can go straight to the crux of the issues. So, for instance, it was once the case that lawyers would argue for days simply over definitions. Nowadays that should be rare. Most arguments will go relatively swiftly to, say, how and when an indemnity might be triggered.

As awareness of the terms and effects of the Statutory Contaminated Land Regime grew so, necessarily, did attention to associated areas. The interface (or in some instances the lack of interface) with other relevant bodies of existing and future laws (e.g. nuisance, negligence, contract, legislation in respect of planning, waste, water and radioactivity, IPPC and the EU White Paper on environmental liability) has been particularly interesting. These have given innovative organisations and their legal advisers prospects for exploiting new opportunities and creating new contracts and contractual relationships. Further, as time has gone by the entrepreneurial and innovative have sought to find and define more approaches and solutions to transactional indemnities caused by contaminated land. So for instance, warranties and indemnities are often now more tailored than used to be the case; contractual remediation obligations and objectives, both pre-acquisition and post-acquisition, are more common; insurance and other security (such as bonds and escrow accounts) for risks are regularly discussed; contractual acknowledgements, recitals and clauses have been invented to attract (or circumvent) some of the risk transfer provisions contained in the guidance to the Statutory Contaminated Land Regime; "pie-crust" leases are sometimes used, again as a mechanism to avoid some of the risks; commercial organisations are being set up to acquire and develop contaminated land or joint venture with the owner in development of the owner's contaminated land.

No doubt there will be further developments and refinements in legal practices relating to contaminated land, particularly once a body of case law is developed in relation to the Statutory Contaminated Land Regime. Case law is inevitable because there are many unanswered legal questions and because it is almost inevitable that regulation of the Statutory Contaminated Land Regime will not be consistent across the country. The early decisions of the courts will be very important in this regard. If those early decisions are themselves rational and consistent then this should go a long way to easing the anxiety that is often caused when law is not clear or where regulation appears deficient. So will the courts be rational and consistent? The higher courts (i.e. those above the magistrates courts) should be. Further there are presently discussions under way concerning the establishment of an environmental court that would decide most environmental issues including those relating to contaminated land. If such a

court is established the likelihood of well thought out and consistent judgments must be increased. However, as it presently stands, appeals under the Statutory Contaminated Land Regime go to the magistrates courts. Consistent judgments in those courts cannot be guaranteed. There are mechanisms to have certain cases transferred from the magistrates court to a higher court. Of course a party aggrieved at the decision of a magistrates court can appeal to higher courts. Hopefully the higher courts will be involved when points of legal principal or clarification are at stake otherwise we may face a substantial number of what would otherwise be unnecessary litigious disputes.

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## CL:AIRE (Contaminated Land: Applications In Real Environments)

Linda Quinn

### 1. Introduction

*CL:AIRE (Contaminated Land: Applications In Real Environments) was established in March 1999 to facilitate the demonstration of remediation research and technology projects, including methods for site characterisation and monitoring, on contaminated sites.*

*CL:AIRE assesses the results of its projects, and disseminates the results to contaminated site owners, researchers, the environmental services industry, and others who have an interest in the remediation of contaminated land. Through its activities, CL:AIRE develops a knowledge base related to the demonstration and evaluation of remedial methods under UK conditions. Over time, this process will reduce uncertainties that often discourage the use of sustainable, alternative technologies, and will encourage the redevelopment of brownfield land.*

*Nine projects have been approved to date, with two more currently awaiting ratification by the CL:AIRE Board. The approved projects comprise four technology demonstration projects and five research projects. This article provides summary information on each of these projects to give an impression of the scope of projects that CL:AIRE is involved in and also reports on how CL:AIRE disseminates information on its projects.*

### 2. Technology Demonstration Projects (TDP)

#### 2.1 TDP 1: Low Temperature Thermal Desorption. BP Amoco/British Aerospace Systems

This project involved a field scale trial of low temperature thermal desorption (LTTD) technology carried out on 40 tonnes of hydrocarbon contaminated soil. The trial examined the feasibility of applying LTTD to full scale clean-up. The redevelopment of a former storage tank site prompted the need to review the viability of remedial

techniques. The soil was primarily fine to medium grained sand, and this together with the volatile nature of the organic contaminants made a LTTD technique suitable.

The trial was designed to assess the remediation method effectiveness and costs, to help develop the necessary operational controls, and to collect initial environmental impact data to aid early discussions with the Environment Agency on licensing issues.

Four batches of contaminated material were prepared with hydrocarbon concentrations of 0.25, 0.5, 1.0 and 2.0%. Each of these were desorbed at temperatures between 200 and 300 °C.

With the exception of the 2% material, they were all successfully treated at feed rates close to the LTTD unit maximum design capacity of 22 tonnes/hour. The 2% material caused high temperatures (>950 °C) in the off-gas oxidiser. Consequently, the feed rate was reduced to 16 tonnes/hour to reduce desorbed fuel flow to the oxidiser and reduce operating temperature.

The removal of benzene was satisfactory at all of the trial temperatures, with residual concentrations >1mg/kg. However, to maintain a suitable operating margin, desorption temperatures in the range 250 to 300°C were recommended.



Low Temperature Thermal Desorption unit

## 2.2 TDP 2: Soil Washing.

### *Lattice Property Holdings Ltd/VHE*

This project involved the cleanup of approximately 150,000 tonnes of ammonia, phenolic and poly aromatic hydrocarbon (PAH) contaminated soil at the Basford Gasworks. The work was completed in 1998. Lattice Property Holdings Ltd (formerly BG Property Holdings Ltd), working closely with the Environment Agency and the Environmental Services Department of Nottingham City Council, selected soil washing for the cleanup based on a comprehensive site characterisation programme. The objectives of the cleanup were to:

- Remove contaminants from the soil, and optimise re-use of treated soil.
- Improve safety conditions in the area by reducing vehicular traffic to and from the site.
- Reduce need for landfill and primary aggregates.

A pilot study was conducted on the site to select and scale the most appropriate unit processes so that an integrated plant could be constructed for full scale cleanup. The pilot study was a critical component in the overall project and allowed the soil washing contractor to assess the technical and financial risks and thus arrive at unit costs for the process.

The project concluded that site remediation by waste minimisation methods was an energy efficient, economically attractive and environmentally beneficial option compared to dig and dump.

## 2.3 TDP 3: Permeable Reactive Barrier.

### *Nortel Networks/Golder Associates/The Queen's University Belfast/Keller Ground Engineering Ltd*

A Nortel (Northern Telecom) manufacturing facility in Monkstown, Northern Ireland has been used for manufacturing and assembly over the past 40 years. During detailed site investigations, high levels of VOC contamination including trichloroethylene (TCE) were found in the groundwater. The source of contamination was thought to be from the former storage of chlorinated solvents at the site.

Golder Associates were commissioned to remediate the contaminated groundwater. It was determined that a zero valent iron permeable reactive barrier (PRB) scheme would treat the groundwater as it migrated off site. A PRB was installed in 1996 along the site boundary using zero valent iron as the reactive material to dehalogenate the chlorinated solvents in the groundwater. The major contaminant was trichloroethylene (TCE). This was the first zero valent iron PRB to be installed in Europe.

The concept of a PRB involves the installation of reactive material in the subsurface to intercept a plume of contaminated groundwater, typically under its natural gradient, thereby creating a passive treatment system. As the contaminant moves through the material, reactions occur that transform it to less harmful or immobile species. In this case, zero valent iron in the form of granular iron has been used as the reactive medium. Zero valent iron has

demonstrated an ability to dehalogenate TCE dissolved in a groundwater plume.

This project involved six distinct phases:

- Detailed site investigation and groundwater modelling;
- Development of a laboratory scale feasibility study;
- Numerical model and conceptual design of funnel and gate system;
- Detailed design of funnel and gate system;
- Reactive barrier construction;
- Long term monitoring of the groundwater around the wall.

Recently, The Queen's University Belfast (QUB) excavated portions of the barrier to assess the performance of the technology using mineralogical techniques (scanning electron microscopy), geochemical methods (carbon isotopes) and groundwater modelling.

## 2.4 TDP 4: Bio-slurry Reactor.

### *Advantica Technologies Ltd*

This project aims to demonstrate at a former coking works, the feasibility of a bio-slurry reactor, developed by Advantica (formerly BG Technology). The bio-slurry reactor is relatively new in the UK. It has already been demonstrated at a former gasworks in the UK to treat coal tar contaminated material. The difference between the bio-slurry reactor and more conventional ex-situ bioremediation techniques is that the bio-slurry reactor involves an enclosed vessel in which conditions, which promote the growth of microbes, are highly controlled. Under such conditions, normally difficult to treat contaminants, such as heavy PAHs (e.g. benzo-a-pyrene), can be broken down at a faster rate. This has important implications to the cleanup of coal tar material and heavy hydrocarbons because the difficult to treat contaminants are often the toxic drivers in risk-based cleanup.



*Bio-slurry Reactor*

The project aims to:

- Demonstrate the potential treatment of coal tar material;
- Provide independent assessment of the technology; and
- Determine the parameters for the most effective process and economic operation of the reactor.

### 3. Research Projects (RP)

#### 3.1 RP 1: Predicting Spatial Uncertainty in Pollutant Movement from Contaminated Land.

**Dr Fred Worrall, Durham University**

This project seeks to understand the variability of parameters controlling pollutant movement through contaminated sites as a means of enhancing risk assessment and improving the risk-based management of sites. The project will apply state-of-the-art chemical methods to the problem of understanding adsorption behaviour and use Bayesian statistical techniques as a means of linking predictors of adsorption variability to measurable site parameters. The project will deliver a generic tool for adsorption prediction to be used by the contaminated land practitioner, which can work with models such as ConSim.

One of the dominant chemical controls on the transport of organic pollutants to groundwaters is adsorption. Adsorption is the attraction between the pollutant and other particles in the subsurface, which retards pollutant movement. The adsorption of organic pollutants is largely controlled by the presence of naturally occurring organic matter. Adsorption coefficients ( $K_{oc}$ ), which are normalised to organic matter, have been reported for a wide range of organic pollutants as constant values and are used extensively in fate and risk models. Yet the  $K_{oc}$  value for any one compound is far from constant and values can vary by orders of magnitude. In order to model pollutant transport from contaminated sites, the variability in adsorption parameters must be understood and predictable. Moreover, this prediction must be a practical possibility for consultants and contractors who work in the field.

The project is being carried out over a three-year period and will use samples from several CL:AIRE field sites. The results of the project will:

- Improve site investigation methodologies;
- Develop risk-based management and remediation of contaminated sites based on a greater understanding of uncertainty and variability in parameters controlling pollutant movement to controlled waters;
- Give added value to existing regulatory transport models; and
- Deliver a user-friendly technology, validated against well-characterised field sites.

#### 3.2 RP 2: Hydro-biological Controls on Transport and Remediation of Organic Pollutants for Contaminated Land.

**Professor Howard Wheeler, Imperial College London, Professor Jeremy Mason, Kings College London and Lattice Property Holdings Ltd**

This project involves innovative methods for characterising bioactivity at contaminated sites.

The proposed research will provide a unique understanding of the role of heterogeneity in physical and chemical properties in relation to both organic contaminant migration and microbial activity at the field scale. Advanced, innovative genetic technology will be applied to characterise existing and potential microbial activity, and hence identify potential for enhancement, and will evaluate impacts of enhancement methods. Modelling will be developed to interpret the complete process interdependence and generalise the results, hence providing a new tool for assessment of groundwater pollution from the site under natural conditions and the impacts of remedial design on reducing/removing this risk to groundwater.

More specifically, the research aims to

- Investigate contaminated soil at a representative former gasworks site and quantify the physical, hydrological and chemical characteristics and assess the transport of organic contaminants to groundwater;
- Evaluate in-situ microbial biodegradative activity using reverse transcriptase polymerase chain reaction (RT-PCR) techniques and test and assess the potential for enhancement;
- Incorporate the information on biodegradative activity within a modelling framework, in order to predict the long-term impact of current and enhanced in-situ bioremediation;
- Develop a decision support system to provide guidance for bioremediation design for groundwater protection.

#### 3.3 RP 3: Processes Controlling the Natural Attenuation of Fuel Hydrocarbons and MTBE in Chalk.

**Dr Steve Thornton, Sheffield University**

This research will develop a general process model of natural attenuation of petroleum hydrocarbons and MTBE in dual-porosity aquifers. A combination of field, laboratory and modelling studies will be used to identify controls on the migration and degradation of BTEX and MTBE hydrocarbons. Novel stable isotope studies and molecular microbial analysis will be used to assess spatial and temporal variations in degradation, as a function of aquifer hydrogeology and contaminant distribution. Parameter values of processes and properties controlling natural attenuation will be determined, enabling the process model to be validated at field-scale. The key objectives are to:

- Determine if aerobic degradation is important for MTBE in the chalk aquifer;
- Identify factors controlling degradation in the aquifer and estimate parameter values for processes;
- Identify whether degradation occurs in the fractures or matrix;
- Understand how dual-porosity flow affects the potential for biodegradation;
- Demonstrate the validity of the conceptual model and parameter values.

This project has joint funding through industry and EPSRC. Preparatory work has already started on site with the drilling of three monitoring wells. Each well has been completed with the installation of an innovative, multilevel monitoring system, which will allow the measurement of groundwater head and chemistry at seven discrete locations. This information will be used as input data to a 3-D numerical model of groundwater flow and contaminant mass transport.

#### **3.4 RP 4: The Development of a Statistical Model to Optimise Investigation to Characterise Contaminated Land**

**Dr Mike Ramsey, Centre for Environmental Research, University of Sussex**

The object of this research is to develop a statistical method to balance the cost of a site investigation against the potential financial consequences of mis-classifying a contaminated site. The model will quantify how much money should be spent on a site investigation at sites where significant financial liabilities may be incurred if contamination was either missed or identified incorrectly. The model will be developed into a decision tool to assist contaminated land practitioners objectively to justify higher or lower expenditure on investigations for certain sites. The method aims to quantify the uncertainty of the contaminant concentration values, including uncertainty arising from field sampling techniques. It will also be used to calculate the risks that are involved in mis-classifying a site, and will improve the estimates of financial risk taken by site developers.

#### **3.5 RP 5: The Use of Bonemeal Phosphates to Stabilise Metal Contamination**

**Dr Eva Valsami-Jones, Department of Mineralogy, The Natural History Museum**

The Natural History Museum is undertaking research to assess the effectiveness of bonemeal as an in situ remediation medium for the stabilisation of metals in contaminated soils.

Laboratory studies carried out by the Natural History Museum on experimental phosphate formation suggest that a micro-crystalline form of apatite, such as it occurs in bonemeal, could be a more effective source of phosphorus, as it has a higher solubility than rock apatite, but not too soluble to be readily leached from soil. In water, hydroxyl-apatite, the main component of bone, dissolves to release calcium, phosphate and hydroxyl ions. The phosphate is free to combine with metal contaminants to form new insoluble phases. A pattern of constant release of phosphate, until all hydroxyl-apatite is replaced by a metal phosphate is observed. This is coupled with a reduction in acidity due to the release of hydroxyl.

The project aims to:

- Demonstrate that bonemeal treatment has the same effect (i.e. lowering of metal concentrations in soil pore waters, reduction in metal availability, increase in pH) in the field as in laboratory trials;

- Demonstrate that metal immobilisation is irreversible under field conditions;
- Assess the toxicity and metal bioavailability of soils before and after treatment;
- Test that the treatment will also promote the restoration of biological activity in the soil;
- Assess potential uses for site following treatment.

## **4. Dissemination of Information**

CL:AIRE transfers authoritative, scientifically credible project information to organisations and individuals with an interest in contaminated land. It publishes project reports describing its projects and presenting the project results. In addition to these reports, CL:AIRE provides project updates and project summaries which are made available via the CL:AIRE web site ([www.claire.co.uk](http://www.claire.co.uk)), fact sheets and future workshops. Parties involved in the clean up of contaminated land can use the results to find out about different clean up technologies, assess the technical risks and estimate the cost of full-scale clean up.

CL:AIRE view, a quarterly newsletter; provides information on CL:AIRE activities, and contains articles on a broad range of issues related to contaminated land. This is distributed free of charge to more than 4000 readers. In addition, there are regular reports on various sectors involved in contaminated land both within the UK and internationally.

For further information about CL:AIRE please contact Linda Quinn on +44 (0) 20 7723 0806, or by email at [enquiries@claire.co.uk](mailto:enquiries@claire.co.uk).

# Biological Techniques for Contaminated Land – Case Studies

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*Key words: contaminated land, risk assessment, remediation, knowledge transfer, ecotoxicology, bioremediation, phytoremediation*

## Background

Traditional techniques for risk assessment and remediation of contaminated sites have technical, financial and practical limitations. For example, analytical testing is most commonly used for measuring the degree of contamination on a site, however the results give no indication of the toxicity or bioavailability of the contaminants present. Similarly, excavation and disposal has traditionally been the preferred option in the UK for the remediation of soil contamination, but is becoming more expensive due to rising landfill disposal costs, and is increasingly seen by regulators and other stakeholders as being unsustainable. As a result, there is a growing need for more cost-effective and sustainable techniques to be applied to the assessment of risk and remediation of contaminated sites.

Bioremediation fits in well with the UK Government's drive towards sustainable approaches to environmental management. Nevertheless, like many emerging technologies, the uptake has been relatively poor in the UK. This is due in part to a number of technical (e.g. inhibitory effects on microbial activity), legal (e.g. waste management licensing), financial (e.g. project cost overruns) and practical factors (e.g. space and time constraints). In some cases preclusion of bioremediation has been justified. In other cases, a lack of confidence may have unjustifiably ruled out biological techniques, if indeed bioremediation was considered in the first place.

There are two broad categories of application of biological techniques on contaminated sites.

- *Risk assessment and monitoring of remedial options (Biological test methods)*

Although few biological test methods have been deployed commercially on UK sites, a number are beginning to be developed, including *in situ* and *ex situ* bioassays, toxicant response tests, biomarker and biosensor tests, and the use of bio-indicator species. Earthworms have been successfully deployed in bioassay tests on sites, the effects of exposure to contaminated soils being studied on their return to the laboratory. Biomarker tests of exposure, such as the neutral red retention assay, have been used to reflect the bioavailability of toxic compounds in soils, while biosensors such as Microtox and lux gene modified organisms have proven particularly useful for the assessment of organic compounds.

- *Stand-alone bioremediation solutions and components in a 'treatment train' approach (Remedial technologies)*

Bioremediation techniques that have been used commercially in the UK include monitored natural attenuation (MNA), biosparging, solid-phase redox ameliorants, landfarming, and biopiles/windrows. Other emerging techniques, such as precipitation of metal contamination and short rotation coppice (SRC) for phytoremediation have been tested at field scale in the UK, but mainly for research purposes. A number of other techniques – including the use of hyperaccumulators – are under development but have not yet undergone significant field scale testing in the UK.

## The Research

The Construction Industry Research and Information Association (CIRIA) Research Project 625, *Biological treatment for contaminated land - case studies* has identified a number of recent case studies that illustrate the advantages of using biological techniques, as well as highlighting circumstances where limitations in their use may apply. The case studies have been selected so as to reflect current practice in the commercial application of biological techniques on brownfield sites in the UK. Lessons learnt from the case studies were used to prepare guidance for the construction industry on the selection and use of such techniques.

## Methodology

The research has been undertaken in the following four main phases:

1. Identification and screening of case studies
2. Development of case study assessment criteria
3. Assessment of case studies
4. Preparation of guidance

### 1. Identification and Screening of Case Studies

Case studies were identified through consultation with UK practitioners, backed up by a review of literature in the technical and trade press. In view of the limited number of key 'players' in the UK, the potential sensitivity of the information sought, and the poor return rate generally experienced by questionnaire-based surveys, a more focused and personal consultation exercise was undertaken to encourage the participation of consultees. Networks and associations were also used to appeal for information.

A screening approach was used to select the most appropriate case studies, and to help focus the data collation exercise. Screening criteria are listed in Table 1, together with the grading system used to determine the suitability of the case study for inclusion in the research.

**Table 1.** Case Study Screening Criteria

Factor	'Suitability' of case study for inclusion in the research		
	Low	Medium	High
Current status	Project not yet commenced	Project ongoing	Project complete
Reporting restrictions	No reporting possible	Some reporting restrictions	No significant restrictions
Commercial status	Research study	Full scale research study	Commercial application
Existing publicity	Widely publicised and documented	Limited prior publicity	No prior publicity
UK applicability	Non-UK study, UK organisations	Non-UK study, UK organisations	UK study

The case studies were selected to reflect current practice in the commercial application of biological techniques on brownfield sites in the UK, under a range of circumstances or contexts. The project therefore focused on the selection of case studies illustrating full scale commercial projects that have recently been completed. A list of selected case studies is shown in Table 2.

**Table 2.** Case Studies

Technique(s)	Context of application	Principal contaminant treated/ assessed
<b>Bioremediation case studies</b>		
Landfarming	Divestment	Lube oil
MNA	Site redevelopment	Nitrobenzene
MNA	Divestment	BTEX
Bio-sparging	Voluntary	BTEX, PAH, Phenol
Groundwater recirculation	Pollution incident response	Diesel fuels and JP-8 aviation fuel (BTEX).
Solid phase redox ameliorants (ORC)	Voluntary remediation	BTEX
Windrows	Voluntary remediation	TPH, benzene, isopropylbenzene
Windrows	Divestment	PAH
Treatment beds	Divestment	PAH
<b>Case studies for assessment of risk</b>		
In situ and ex situ bioassays, biomonitoring, biomarker and bioavailability studies	Research	Metals mixture (Zinc, Cadmium, Copper, Lead primarily)
In situ earthworm bioavailability, bioassay and Biomarker tests.	Research	PAHs, Metals, Inorganics (Cyanides, Sulphides etc.)
In situ and ex situ (OECD) earthworm Bioassays and bioavailability tests. Ex-situ plant germination tests. Ex-situ Collembolan (OECD) tests. In situ and Ex situ soil invertebrate biodiversity measurements.	Research	Metals (ex mining and smelting site)
Ex situ bioassay	Voluntary remediation	Creosote

A number of other remedial techniques are under development, but have not yet seen widescale commercial application the UK. Examples include bioventing, bioslurry reactors and phytoremediation. It was not considered appropriate to include case studies of such emerging techniques for inclusion in the guidance. However, summaries of applications to date were included, in order to illustrate their potential future commercial application.

2. Development of Assessment Criteria

The case studies were reviewed and assessed against a range of criteria, including technical, financial, regulatory and practical issues. The criteria were developed from an 'evaluation matrix', shown in Table 3. This matrix provided a framework for conducting the assessments, by grouping information into three broad categories:

- Classification Criteria (information describing the contamination problem and the technology applied to it);
- Assessment Criteria (evaluating the performance of the technology against expectations); and
- Selection Criteria (conclusions drawn from the assessment).

The information required to assess case studies against these criteria varied according to site-specific circumstances, but they all include examples of site-specific information that were used to assess case studies:

- site setting/conditions (geography/ site location, size, topography, access etc);
- ground conditions (geological, hydrogeological);
- contamination characteristics (concentrations, phases, distribution, pollutant linkages);
- 'driver' or context of remediation (e.g. planning, voluntary action, regulatory requirement);
- operational boundaries (e.g. remedial objectives, available timeframe, budget constraints);
- technology boundaries or 'operating windows'
- system performance (e.g. success in attaining remedial objectives, cost efficiency, energy/raw material usage, verification testing/post monitoring data); and
- environmental impacts, such as noise, odour, traffic movements, as well as wider issues such as public acceptability and sustainability indicators.

Table 3. Case Study 'Evaluation Matrix'

Classification Criteria		Assessment Criteria	Selection Criteria
1 Problem Description	2 Technology description	3	4
1a Nature of Contamination	2a Trade name etc	3a Technical suitability against goals set in 1d	4a Risk Management role
1b Site Description	2b Type (biosensor, biopile, SRC etc)	3b Use of time and resources against predictions in 2c	4b Technical Suitability (for site, time, resources, problem and status etc)
1c Status (at planning stage, SI stage, remediation stage etc)	2c Time and resource requirements (energy, infrastructure, services, time, costs etc)	3c Costs	4c Cost Effectiveness
1d Project goals and drivers (redevelopment, transactions, insurance/finance, incident, other)	2d Technology description (what it is intended for, what is its envisaged durability, reliability, practicability)	3d Wider impacts	4d Impacts (from a sustainable development context - i.e. environmental, resource, economic - ties in with 4c and social, ties in with 4e)
		3e Stakeholder perceptions	4e Stakeholders' views and their impact on feasibility for future projects
		3f Initial appropriateness (fit between 1d and 2d)	4f Durability, reliability, practicability

A prioritised approach was used to help to focus the data collation exercise. Highest priority was given to primary data, i.e. that were capable of direct measurement and linked to a legal, regulatory or other standard. The next level of priority was given to secondary data that are capable of numeric measurement but not linked to a standard. The lowest level of priority was given to tertiary data that are not numerically quantifiable.

### 3. Assessment of the Case Studies

The case studies were assessed in the following steps:

- **Step 1** - Data collation

Case study information was obtained, including raw data and reports, and anecdotal views gained using structured telephone prompts and meeting scripts.

- **Step 2** - Gap analysis

Information gaps were identified using an evaluation matrix, and Step 1 repeated if necessary.

- **Step 3** - Case study assessment

A semi-quantitative and qualitative assessment of case study information was performed, using the assessment criteria.

- **Step 4** - Validation of assessment

Initial case study assessments were subjected to peer review and presented for discussion at a workshop.

To enable an objective comparison of the relative advantages and limitations of techniques to be made, it was important to maintain consistency when evaluating case study information. The prioritised approach to case study selection and data collation maximised the objectivity of assessments. Nevertheless, subjective expert judgement was still required to evaluate certain aspects of case studies, such as stakeholder acceptability. In addition, it was recognised that different consultees views on the 'success' or 'failure' of the same case study was likely to vary depending on their expectations, involvement and interest with the case. The consultation workshop was therefore important in gaining a consensus on the case study assessments, as well as obtaining stakeholder views on the advantages and limitations of applying biological techniques on contaminated sites.

### 4. Preparation of Guidance

The findings of the case study assessments were used to generate guidance on the selection and application of biological techniques on contaminated sites. The guidance will act as a practical handbook for practitioners and problem holders and facilitate the design, planning and implementation of biological techniques on contaminated sites.

The guidance document:

- covers the broad range of applications for biological systems, from the early stages of contaminated site risk assessment through remediation design/planning to implementation, validation and after-care;

- is related to the various contexts in which biological systems are, and can be, applied in the UK, i.e. redevelopment; transactions; pollution incidents; regulatory intervention and environmental/asset management;
- is focused on practical lessons learned from case studies;
- fully addresses technical, financial, legal, regulatory, practical and social issues surrounding biological systems; and
- complements, rather than duplicates existing guidance as well as forthcoming guidance developed by UK regulatory bodies on the assessment and treatment of contaminated land. The report signposts key complementary documents, thereby enabling practitioners to obtain further technical and procedural guidance.

The case study report will be available from CIRIA in early 2002.

The authors and CIRIA wish to acknowledge the work of all those involved in CIRIA Research Project 625, Biological treatment for contaminated land – case studies study and the funding from the Department of Trade and Industry through the BIO-WISE Programme, AstraZeneca, BP Amoco Group, Shell Global Solutions, The BOC Foundation, Shanks, AEA Technology and CIRIA Core member organisations, without which none of the work could have been done.

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# Method for Assessing Potential Adverse Effects of Substances in Soil on Designated Terrestrial Ecosystems

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*The contaminated land provisions of Part IIA of the Environmental Protection Act 1990 broadly require that land be designated as contaminated, if harm is being caused or controlled waters are being polluted. Remediation of land identified as contaminated is required under Part IIA such that harm or pollution of controlled waters is no longer being caused. Harm includes harm to the health of living organisms or interference with ecological systems of which they form a part. In determining whether harm is significant, the ecotoxicological effects of the contaminant need to be considered, using information which is both scientifically-based and authoritative. The level of protection should ensure that there is no irreversible or other substantial adverse change in the functioning of the ecological system.*

A method has been developed that can be used to derive site-specific numeric targets to minimise potential adverse effects on designated terrestrial ecosystems arising from contaminants in soil. The work was commissioned by the Scotland and Northern Ireland Forum for Environmental Research (SNIFFER) and has been undertaken by WRC-NSF Ltd. SNIFFER initiated this research to support regulatory activity that will be undertaken in accordance with Part IIA. Although the methodology was primarily aimed at assisting the regulator with establishing remedial objectives for contaminated soil, it is envisaged that it may also be used to establish site specific assessment criteria. It is intended that the method will be applied on a site by site basis as appropriate. It should not be used to generate generic targets. Furthermore, any numeric targets derived using the method will not replace any national guideline values.

There are two approaches that can be taken in the regulation of contaminated land to minimise potential adverse effects to ecosystems: one considering whether the concentration of contaminants present are likely to result in "harm", the chemical approach; and the other measuring the effects of contaminants on ecosystems, the direct toxicity assessment approach. The SNIFFER project has addressed the chemical approach and the direct toxicity assessment approach is being addressed by a parallel project managed by the Environment Agency, but to which SNIFFER is also making a financial contribution.

The chemical approach developed has utilised available data on terrestrial ecotoxicity for species and soil functioning processes, and applied a statistical analysis to derive target concentrations aimed at minimising adverse effects to ecosystems. In order to obtain realistic target values which are protective of 95% of species, numerous datasets are

required. However, for most chemicals there is a paucity of data and the method also provides the option of applying uncertainty factors. An overview of the seven key steps involved in the method is provided below:

1. Collection and assessment of data on the soil at the contaminated site (e.g. pH, % organic matter, % clay, cationic exchange capacity, background concentrations, essential concentrations).
2. Collation and assessment of environmental data (contaminant fate and behaviour, effects on individual species and microbial processes and the potential for bioaccumulation) and a consideration of the acceptability of the available data for deriving numeric targets.
3. Derivation of a preliminary numeric target for the protection of ecosystem structure (NT<sub>s</sub>). The derivation of a preliminary numeric target is carried out using a 'probabilistic' approach if  $\geq 4$  values for effects on four different taxa (including at least one plant or invertebrate species) are available. The probabilistic approach involves applying an uncertainty factor to the mean of the species sensitivity distribution using an established modelling approach. If values are only available for effects on 2-3 different taxa (including at least one plant or invertebrate species) then a "deterministic" approach is used in which an uncertainty factor is applied to the lowest of the values. No preliminary NT values are derived if data for effects on only one taxa are available.
4. Derivation of a preliminary numeric target for the protection of ecosystem function (NT<sub>f</sub>). The derivation of a preliminary numeric target is carried out using a 'probabilistic' approach if  $\geq 4$  values for effects on four microbial processes (including nitrogen fixation or nitrification) are available. The probabilistic approach involves applying an uncertainty factor to the mean of the species sensitivity distribution using an established modelling approach. If values are only available for effects on 2-3 different microbial processes (including nitrogen fixation or nitrification) then a "deterministic" approach is used in which an uncertainty factor is applied to the lowest of the values. No preliminary NT values are derived if data for effects on only one microbial process is available. In certain instances where organic compounds act as a carbon source for microbes, NT<sub>f</sub> may not need to be derived.
5. Derivation of an overall site-specific numeric target as the lowest of the preliminary NT values.
6. Consideration of the need to incorporate the potential for secondary poisoning and comparison of the derived numeric target with:
  - the site specific background concentration;

- the limit of detection for the substance by the chosen analytical method;
  - the essentiality of the substance.
7. Consideration of any subsequent action based on the measured contaminant concentrations and the overall numeric target. Scientific judgement should be used in assessing the appropriateness of the overall NT value for the site of concern.

In developing a method, the intention was that it should provide a quick, practical, scientifically valid approach to deriving numeric targets. It was not meant to cover all circumstances and it therefore has a number of limitations. These limitations include not accounting for the effects of complex mixtures of chemicals, requiring data for more than one species and assuming 100% exposure for all land uses and 100% bioavailability. Professional judgement should always be used in deciding which is the most appropriate method to follow for a particular site. In many cases, there may be benefit in adopting a direct toxicity assessment approach.

The scope of the work is confined to the technical aspects of deriving numeric targets. Other issues, such as costs and benefits, reasonableness, technical viability, local environmental concerns and other related matters need to be considered separately, once the numeric target has been derived. Any remediation objective applied to a site is likely to be a negotiated value, derived by considering all such matters.

It is considered that the report and underpinning work is only a starting point, and that the understanding and application of science in this area will continue to develop.

The report detailing the method is available from the Foundation for Water Research (FWR), Allen House, The Listons, Liston Road, Marlow, Bucks SL7 1FD. Tel: 01628 891589; email: [office@fwr.org.uk](mailto:office@fwr.org.uk), web site [www.fwr.org](http://www.fwr.org)

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*Further information about SNIFFER can be found on the web site: [www.sepa.org.uk](http://www.sepa.org.uk).*

# Research

## Sulphur Dioxide Emissions from Small Boilers – Supplementary Assistance on Stack Height Determination

Y. Vawda, J.S. Moorcroft, P. Khandelwal and C. Whall<sup>1</sup>

Stanger Science and Environment

*The Air Quality Strategy (2000)<sup>2</sup> recognises that despite national measures to control SO<sub>2</sub> emissions from combustion plant, there may still be some exceedances of the 15-minute mean objective in very local areas in the immediate vicinity of small combustion plant less than 20 MW. Currently, chimney height calculations cannot be carried out easily for many of these boilers due to a number of limitations in the available methods.*

*At the request of the Department of the Environment, Transport and the Regions (DETR) (now Department for Environment, Food and Rural Affairs – DEFRA), Stanger Science and Environment (SSE) has produced supplementary technical assistance for estimating the minimum permissible chimney height for small boilers emitting SO<sub>2</sub>. This simple, screening tool is in the form of an EXCEL spreadsheet, and is available on the SSE website ([www.stanger.co.uk/airqual/modelhlp/helpline.htm](http://www.stanger.co.uk/airqual/modelhlp/helpline.htm)).*

### 1. Background to the Study

The Government and the devolved administrations have adopted a 15-minute mean of 266  $\mu\text{g m}^{-3}$  as an air quality standard for sulphur dioxide (SO<sub>2</sub>), with the objective for the standard to be achieved as the 99.9<sup>th</sup> percentile (equivalent to no more than 35 exceedances per year) by the end of year 2005. Less stringent 1-hour mean and 24-hour mean objectives have also been adopted, which are to be achieved by the end of 2004.

Many small boilers (i.e. those less than 20 MW) are not regulated by local authorities, as they do not come within Part B of the Environmental Protection Act 1990; these are subject to control under the Clean Air Act 1993, s.15. Even some boilers which are regulated under local authority air pollution control (LAAPC) cannot be adequately assessed for their air quality impact, due to the limitations of available methods for stack height determination.

The screening techniques which are currently available, and their shortcomings with respect to stack height determination for small boilers, are described below.

#### 1.1 Third Memorandum on Chimney Heights<sup>3</sup>

The Chimney Heights Memorandum provides guidance for local authorities and industry on calculating the minimum stack height of fuel burning plant with gross heat input of between 0.15 - 150 MW. This method was formulated under the former Clean Air Act 1956, prior to the implementation of the AQS air quality objective for SO<sub>2</sub>.

The guidance in the Chimney Heights Memorandum was based on an assessment criterion of 452  $\mu\text{g m}^{-3}$  averaged over a time period of a nominal 3 minutes<sup>4</sup>. There is no straightforward comparison of this against the 15-minute mean AQS objective of 266  $\mu\text{g m}^{-3}$ , expressed as a 99.9<sup>th</sup> percentile. Therefore, a calculated stack height using the Chimney Heights Memorandum may not be sufficient in all cases to guarantee compliance with the most stringent, 15-minute mean air quality criterion.

The Chimney Heights Memorandum cannot be used to determine the stack height of emissions with an efflux velocity of less than 6 m s<sup>-1</sup>; it does not take account of the actual efflux velocity for the plant. Background levels of SO<sub>2</sub> are treated simply in five categories (ranging from 'undeveloped area' to 'large city'), and more importantly, do not include projections of the much lower SO<sub>2</sub> background concentrations in year 2005 compared to the 1980s.

#### 1.2 D1<sup>5</sup>

The D1 method calculates stack heights using the 98<sup>th</sup> percentile envelope of worst case meteorological conditions. This could be inadequate for assessing the 99.9<sup>th</sup> percentile concentrations required for SO<sub>2</sub>, which can depend on more extreme weather conditions. Moreover, the D1 method cannot be used with efflux velocities of less than 10 m s<sup>-1</sup>. The method is based upon a time-averaged concentration of 15-30 minutes.

An analysis carried out in 1995 used the database of dispersion calculations which comprised the D1 method, to consider the probability of exceedance of an air quality standard for SO<sub>2</sub> of 266  $\mu\text{g m}^{-3}$  as a 100<sup>th</sup> percentile<sup>6</sup>. The

<sup>1</sup>Currently at Entec UK, 17 Angel Court, City Rd, London EC1V 2SH

<sup>2</sup>The Air Quality Strategy for England, Scotland, Wales and Northern Ireland, January 2000, DETR.

<sup>3</sup>Chimney Heights – Third Edition of the 1956 Clean Air Act Memorandum, 1981, The Stationery Office

<sup>4</sup>Approximate Estimates of the Frequencies of Exceedance of the New EPAQS Short Term Air Quality standard for Sulphur Dioxide due to Local Stack Discharges, November 1995, BRE Report CR 223/95, DETR

<sup>5</sup>D1 – Technical Guidance Note (Dispersion) D1 – Guidelines on Discharge Stack Heights for Polluting Emissions, HMIP 1993, The Stationery Office

<sup>6</sup>Approximate Estimates of the Frequencies of Exceedance of the New EPAQS Short Term Air Quality standard for Sulphur Dioxide due to Local Stack Discharges, November 1995, BRE Report CR 223/95, DETR

study concluded that the largest possible exceedances are from small boiler plant of around 1 MW capacity and below.

### 1.3 Guidance on Stationary Sources (GSS)<sup>7</sup>

In common with many screening models, the GSS will calculate the maximum ground level SO<sub>2</sub> concentration (expressed as the 99.9<sup>th</sup> percentile of 15-minute means), if the user defines the stack height and other relevant emission parameters. Therefore, the method is the reverse of what is required for a chimney height calculation, and could require a large number of re-iterative modelling runs to be used as a deterministic tool for stack heights.

The GSS model cannot be applied under the following circumstances, which presents limitations for assessing the impact of small combustion plant:

- stacks lower than 20 m;
- stacks with adjacent, significant buildings (i.e. of height at least a third of the stack height);
- stack exit velocities lower than 10 m s<sup>-1</sup> or greater than 25 m s<sup>-1</sup>. (The results presented in the GSS are based on modelling carried out only for an efflux velocity of 15 m s<sup>-1</sup>).

It is noteworthy that the GSS method uses statistically-grouped meteorological data (covering a period of 10 years), rather than hourly sequential readings. This approach takes into account variability in meteorology over the years, but data in this format has the potential for under-predicting ground level pollutant concentrations.

The GSS used ADMS Version 2.02.3. There may be differences in the results for certain scenarios compared against the more recent ADMS Version 3, which has been used in compiling this Supplementary Assistance. However, it was considered important to use the most up-to-date version of the dispersion model.

### 1.4 ADMS-Screen<sup>8</sup>

This is a computerised dispersion model, available under licence from a commercial supplier. In common with most dispersion models, it will calculate the maximum ground level SO<sub>2</sub> concentration (expressed as the 99.9<sup>th</sup> percentile of 15-minute means), if the user defines the stack height and other relevant emission parameters. Therefore, the method is the reverse of what is required for a chimney height calculation, and could require a large number of re-iterative modelling runs to be used as a deterministic tool for stack height.

Although it is relatively simple for a computerised dispersion model, the user still needs some basic knowledge of atmospheric dispersion to understand the input data requests.

## 2. Role of Supplementary Assistance

A need arose for a simple screening tool with which to estimate the minimum permissible stack height for small boilers emitting SO<sub>2</sub>, which would ensure compliance with

the 15-minute mean air quality objective. The Supplementary Assistance which has been developed:

- is simple to use. It would be reasonable to assume that most lay-people are now comfortable with the use of an EXCEL spreadsheet, in preference to a paper-based method, e.g. looking up nomograms or graphs in a handbook;
- focuses only on the range of emission parameters which are encountered for small boilers. However, care has been taken to ensure that the method encompasses the full range of operating parameters for such processes;
- is based on modelling for SO<sub>2</sub>, for compliance against the most stringent AQS objective, i.e. the 99.9<sup>th</sup> percentile of 15-minute means;
- is consistent with the Guidance on Stationary Sources, and other Technical Guidance already issued by the DETR<sup>9</sup>. Pertinent assumptions which have been made to ensure this consistency are listed in Section 4.

## 3. Structure of Supplementary Assistance

The Supplementary Guidance Assistance spreadsheet comprises a summary of the results of a large number of ADMS (Version 3) dispersion modelling runs specifically for SO<sub>2</sub> emissions. The spreadsheet asks the user to define only four parameters, as follows:

- stack internal diameter (m);
- stack volumetric flow rate (m<sup>3</sup> s<sup>-1</sup>);
- background annual mean SO<sub>2</sub> concentration (µg m<sup>-3</sup>);
- SO<sub>2</sub> emission rate (g s<sup>-1</sup>).

The minimum permissible stack height (with and without building wake effects) is automatically displayed. The ranges and combinations of emission parameters which have been modelled in compiling the Supplementary Assistance method are shown in Table 1.

### Functioning of Spreadsheet

The spreadsheet is available on the Modelling Helpline Website<sup>10</sup>. Upon downloading the spreadsheet via the Internet and opening it from the user's local disk drive, the user is faced with an instruction sheet explaining what the model can be used for, how the operator can proceed with entering stack and site parameters, and how to interpret the results. Users who do not have access to the Internet can request a copy of the spreadsheet on floppy disk.

When the user is satisfied with this preliminary information, he is invited to click on the tab at the bottom of the screen and proceed to the next sheet where the input data are defined. At the bottom of this page, the results are displayed.

The functioning of the spreadsheet and the calculation procedures take place on additional, hidden and protected worksheets within the workbook. These cross-reference the parameters input by the user and undertake all the necessary calculations. Within the input sheet, all cells (with

<sup>7</sup>'Guidance for Estimating the Air Quality Impact of Stationary Sources', The Environment Agency, GN24, November 1998

<sup>8</sup>'ADMS-Screen 3 User Guide, April 2000, CERC Ltd, Cambridge

<sup>9</sup>LAQM.TG3(00): 'Review and Assessment: Selection and use of Dispersion Models', May 2000  
LAQM.TG4(00): 'Review and Assessment: Pollutant Specific Guidance', May 2000  
<sup>10</sup>[www.stanger.co.uk/airqual/modelhelp/helpline.htm](http://www.stanger.co.uk/airqual/modelhelp/helpline.htm)

the exception of those into which the user is required to enter information), are locked and password protected.

Considering only the scenario without building wake effects, the model results for the 4 values for the stack diameter are collated independently (Charts A, B, C, and D). For each Chart, 8 different graphs were constructed (A1, A2, A3....etc) of concentration ( $\mu\text{g m}^{-3}$  for unit emission rate' on x axis) versus 'stack height' (on y axis), depending on the value for the volumetric flow rate (V) (see examples in Figures 1-8). Each of these 8 graphs have 15 data points (as 15 stack heights were modelled). The EXCEL spreadsheet computes the mathematical functions for these graphs, to be able to interpolate a stack height from each graph for the required ground level concentration. Finally, the whole procedure is repeated for the model results which include building wake effects.

#### 4. Simplifications in the Supplementary Assistance

A number of assumptions have been made in the modelling, but care was taken to ensure consistency with other DETR guidance.

##### 4.1 Short Averaging Period

A factor of 1.34 was assumed to convert the 99.9<sup>th</sup> percentile of 1-hour mean concentrations predicted by the ADMS-3 model to the 99.9<sup>th</sup> percentile of 15-minute means (as advocated in LAQM.TG4(00)). The GSS also uses this factor of 1.34. The higher factor of 2 would not be relevant as it is more applicable to tall stacks, whereas small combustion plant usually have quite short stacks.

##### 4.2 Meteorology

Meteorological data from Elmdon (Birmingham Airport) only was used in the modelling runs, in contrast with the GSS which employs two additional meteorological datasets. Although there is variability between different regions of the country, the uncertainty in the results of the method (due to the use of only a single meteorological data site) is likely to be smaller than the effects of some of the other simplifying assumptions, e.g. simplification of the building dimensions. Elmdon represents mainland Britain, not influenced by coastal or significant terrain features.

One year of sequential hourly readings were used, for year 1998. This represents the most significant departure from the approach adopted in the GSS, which uses a 10-year statistical meteorological dataset. A sensitivity analysis for four sequential datasets showed that 1998 was the worst year, giving a value for the maximum 99.9<sup>th</sup> percentile concentration 14% higher than 1996, and 21% higher than a 10-year statistical dataset.

##### 4.3 Background SO<sub>2</sub>

The method gives, as a final result, the minimum stack height which will ensure compliance in year 2005, not the existing year. This is more meaningful for the purposes of local air quality management and comparison against the

AQS objectives. For this reason, the user needs to define the local annual mean background concentration<sup>11</sup> of SO<sub>2</sub> for 2005 (the method takes a value of twice the annual mean to represent the background concentration, for adding on to the predicted 99.9<sup>th</sup> percentile of 15-minute means, as advocated in LAQM.TG4(00)). Moreover, the Supplementary Assistance does not itself allow for any emission reduction from the plant in future years; the user must define the SO<sub>2</sub> emission rate for year 2005.

##### 4.4 Building Effects

For each scenario, the modelling was repeated with the inclusion of a single, worst-case building. This was assumed to be a perfect cube, with the stack protruding 3 m above the roof. This is similar to the approach adopted in a previous study<sup>12</sup> into exceedances of the 15-minute mean AQS objective for SO<sub>2</sub>. In both the Chimney Height Memorandum and the D1 method, there is the minimum requirement that a chimney should terminate at least 3 m above the level of any adjacent area to which there is general access (i.e. ground level, roof areas or adjacent opening windows).

The modelling was then repeated again with the roof of the cuboid set 6 m below stack top. It is rare for a building close to a boiler stack to be higher than 40 m. For chimneys up to 40 m, the user is therefore provided with three values for a minimum permissible stack height:

- in the absence of any nearby building;
- with a building 3 m below stack top;
- with a building 6 m below stack top.

For chimneys exceeding 40 m, the user is provided with only two values for a minimum permissible stack height: in the absence of a building and with a building of dimensions 40 m.

##### 4.5 Exit Temperature

A constant exit temperature of 250°C was assumed for all the model runs. Sensitivity analyses carried out for a previous study<sup>13</sup> have shown that under convective atmospheric conditions (i.e. those which give rise to the highest 99.9<sup>th</sup> percentile concentrations), changes in release temperature in the range 100°C-250°C make very little difference to ground level concentrations.

##### 4.6 Surface Roughness

A surface roughness of 1 m representative of urban topography was assumed in the ADMS-3 model runs. This ensures a conservative approach for the calculation of the stack heights, based on sensitivity analyses carried out in a previous study<sup>14</sup>.

##### 4.7 Variable Emissions

The actual SO<sub>2</sub> emission rate (for year 2005) should be provided to the spreadsheet by the user, rather than the maximum emission rate for the plant. If there are known hourly, daily or seasonal variations in emission rate, a

<sup>11</sup>derived from local monitoring data at locations relevant to public exposure, or the DETR Air Quality Archive (<http://www.aeat.co.uk/netcen/airqual>)

<sup>12</sup>Adam, H.S. and Carruthers, D.J. (October 1997), 'Short-term Ambient Concentrations of Sulphur Dioxide in the Vicinity of Small Boilers in the UK', Cambridge Environmental Research Consultants Ltd, Report to the Department of the Environment.

<sup>13</sup>Adam, H.S. and Carruthers, D.J. (October 1997), 'Short-term Ambient Concentrations of Sulphur Dioxide in the Vicinity of Small Boilers in the UK', Cambridge Environmental Research Consultants Ltd, Report to the Department of the Environment.

<sup>14</sup>Adam, H.S. and Carruthers, D.J. (October 1997), 'Short-term Ambient Concentrations of Sulphur Dioxide in the Vicinity of Small Boilers in the UK', Cambridge Environmental Research Consultants Ltd, Report to the Department of the Environment.

sensible approach (to ensure that stack heights are not grossly over-predicted) would be to use the hourly emission rate (expressed as  $\text{g s}^{-1}$ ) averaged over the worst 24-hour cycle likely during the year, i.e. the worst day in the year would be taken into account, but not the worst hour in the year.

#### 4.8 Geographical Extent of Investigation

The ADMS-3 model runs identify the highest predicted  $\text{SO}_2$  concentration within a 3 km radius of the stack; however, the Supplementary Assistance will not give an indication of the area over which exceedances of the 15-minute mean objective occur. Due to the short stacks generally associated with small boilers, the maximum 99.9<sup>th</sup> percentile concentrations are unlikely to occur at greater distances from the stack.

### 5. Limitations of Supplementary Guidance

In common with all screening tools, the results generated by the Supplementary Assistance spreadsheet are subject to certain caveats, which include the following:

- The Supplementary Assistance does not make any attempt to account for local topographical features. This level of detail warrants the use of complex dispersion models and would be outside the scope of a screening tool;
- The method is not able to assess the combined impact of more than one boiler in close proximity. The method is applicable to single stacks only, and the contribution of other sources in the vicinity must be accounted for by means of the background  $\text{SO}_2$  concentrations;
- For the purpose of assessing relevant exposure, exceedances of the 15-minute mean objective are cause for concern only if they occur at non-occupational, near ground level outdoor locations, where members of the public might be exposed over a period of at least 15 minutes. The Supplementary Assistance is very conservative in the sense that a chimney height is calculated by the method which will ensure that the objective is met at all locations, which may in specific cases, fall within the site boundary, or at off-site locations where there is no potential for exposure to the public.

### 6. Comparison of Supplementary Assistance against other Methods

Five methods were used to calculate the minimum permissible stack height for test cases without building wake effects (Test Cases 1): the Supplementary Assistance spreadsheet, ADMS-3 (re-iterative model runs), GSS, D1 and

Chimney Heights Memorandum. Care was taken to choose input data which are within the permitted ranges of all the calculation methods, as well being applicable to small boilers. The input data used are shown in Table 2.

The results of the five methods are shown in Table 3. The Supplementary Assistance method and ADMS-3 calculate very similar stack heights, and higher than from the other methods. The Supplementary Assistance method gives the most conservative result. The GSS indicates stack heights a little lower than ADMS-3, as a result of its use of statistical meteorological data rather than sequential hourly data for a worst-case year (1998). The CHM shows closer agreement to the GSS for the lower stack heights. The D1 method gives the lowest stack height, a feature which is consistent with its use of the 98<sup>th</sup> percentile envelope of meteorological conditions, which would not be sufficient to ensure compliance against an air quality objective expressed in terms of the 99.9<sup>th</sup> percentile.

Four methods were used to calculate the minimum permissible stack height (for compliance against 15-minute mean objective for  $\text{SO}_2$ ) with building wake effects (Test Cases 2): the Supplementary Assistance spreadsheet, ADMS-3, D1 and Chimney Heights Memorandum. Again, care was taken to choose input data which are within the permitted ranges of all the calculation methods. The input data are shown in Table 4, and the results in Table 5.

When building wake effects are included in the calculations, all four methods give very similar results. This is a surprising departure from the comparison described above, which excluded building wake effects. The D1 and CHM have identical procedures for correcting the initial calculated stack height to take into account nearby buildings; this correction procedure accounts for the taller stacks calculated by these methods when buildings are included.

### Acknowledgements

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Great Guildford Street, London SE1 0ES. Tel: 0207 902 6100*

**Table 1.** Model Input Data for Compilation of Supplementary Assistance Method

Parameter	Values modelled	
Stack heights (m)	10 to 80, in steps of 5 m	The method gives a result for a minimum permissible stack height as an integer interpolated between modelled 5 m intervals
Exit temperature (°C)	250 (fixed)	
Volumetric flow rate (m³ s⁻¹)	2.5 to 20, in steps of 2.5 m³ s⁻¹	8 values modelled. The spreadsheet rounds down to the nearest 2.5 m³ s⁻¹ step modelled.
SO₂ emission rate (g s⁻¹)	1	Nominal value, which is pro-rated later in spreadsheet

**Table 2.** Input Data for Comparison Runs: Test Cases 1 (no building wake effects)

Parameter	Value	
Meteorological data	1998 for ADMS3 and Supplementary Assistance	
Buildings	No	
SO₂ emission rate (g s⁻¹)	10, 5, 2, 1	
Stack diameter (m)	0.5	
Exit temperature (°C)	250	D1, GSS and Chimney Heights Memorandum require user to calculate efflux heat Q. This has value of 0.466 MW.
Volumetric flow rate (m³ s⁻¹)	2.945	GSS and D1 require user to calculate efflux momentum M. This has value of 23.904 m⁴ s⁻².
Annual mean background SO₂ concentrations (ug m⁻³)	5	Typical value for an urban area for year 2005.

**Table 3.** Minimum Permissible Stack Heights Calculated by Various Methods for Test Cases 1 (no building wake effects)

Method	Estimated Stack Height (m)			
SO₂ Emission rate	10	5	2	1
Supplementary Assistance	48	27	13	<10
ADMS3	48	25	11	10
GSS	38 <sup>15</sup>	24 <sup>16</sup>	<20 <sup>17</sup>	<20 <sup>18</sup>
D1	16	11	7	5
Chimney Heights Memorandum	22 – 26	19 - 23	12-20	8-14

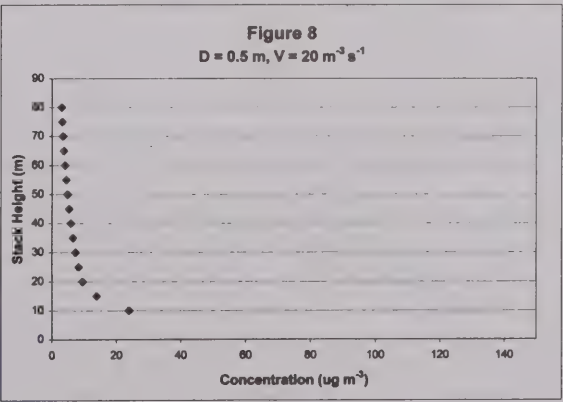
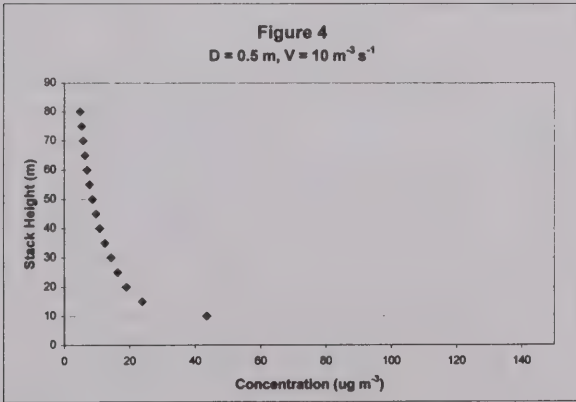
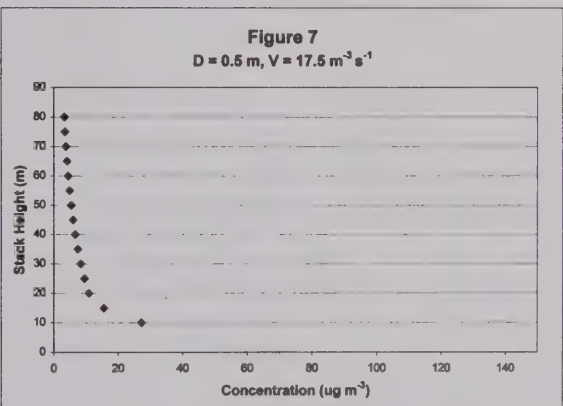
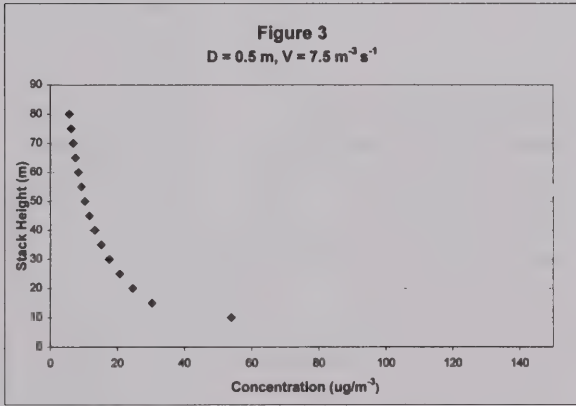
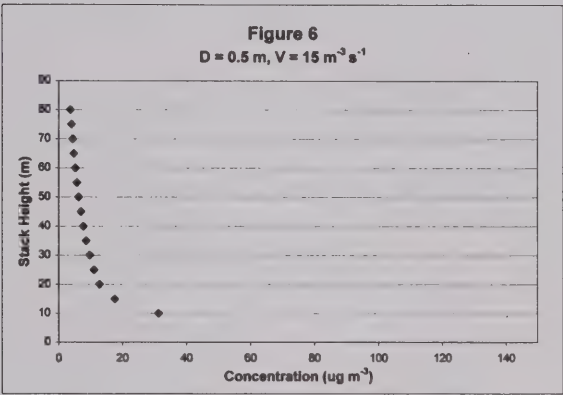
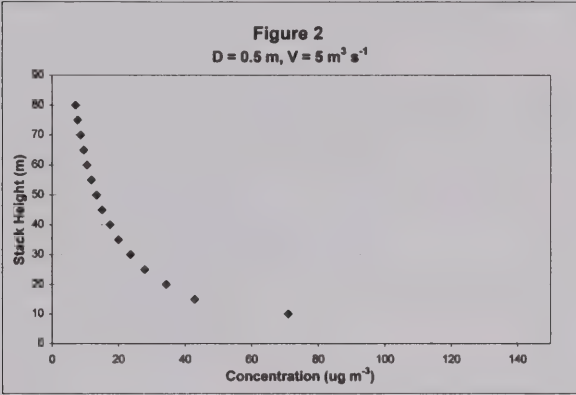
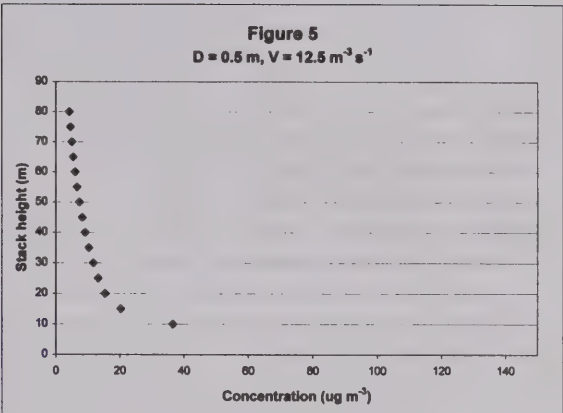
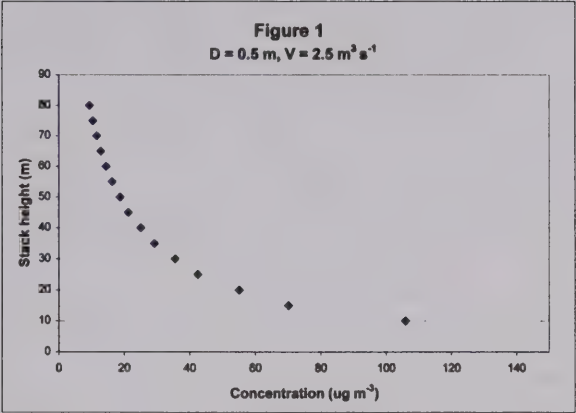
15 Interpolated between contours on look-up graphs  
16 Interpolated between contours on look-up graphs  
17 Outside range of GSS method  
18 Outside range of GSS method

**Table 4.** Input Data for Comparison Runs: Test Cases 2 (with building wake effects)

<i>Parameter</i>	<i>Value</i>
Meteorological data	1998 for ADMS3 and Supplementary Assistance
Buildings heights (m)	14 – 27
SO <sub>2</sub> emission rate (g s <sup>-1</sup> )	0.7 – 2.1
Stack diameter (m)	0.5
Exit temperature (°C)	250
Volumetric flow rate (m <sup>3</sup> s <sup>-1</sup> )	2.945
Annual mean background SO <sub>2</sub> concentrations (ug m <sup>-3</sup> )	5

**Table 5.** Minimum Permissible Stack Heights Calculated by Various Methods for Test Cases 2 (with building wake effects)

<i>Method</i>	<i>Estimated Stack Height (m)</i>					
SO <sub>2</sub> Emission rate	2.1	1.6	1.6	1.1	0.8	0.7
Building height (m)	27	17	29	22	17	14
Supplementary Assistance	33	23	32	25	20	17
ADMS3	32	23	32	25	20	17
D1(with building correction)	38	27	40	30	24	30
D1(without building correction)	7	6	6	5	5	4
Chimney Heights Memorandum (with building correction)	34-40	23-28	35-40	27-31	22-25	18-21
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*The National Society for Clean Air and Environmental Protection produces information, organises conferences and training events, and campaigns on air pollution, noise and environmental protection issues. Founded in 1899, the Society's work on smoke control led to the Clean Air Acts. More recently NSCA has been influential in developing thinking on integrated pollution control, noise legislation, and air quality management.*

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# Noise

## “NOW IS THE WINTER OF OUR DISCONTENT...”

...although whether or not this could be “made glorious summer” by the appearance of a consultation paper on a National Noise Strategy is, of course, open to debate. As those *Clean Air and Environmental Protection* readers who attended NSCA's Noise Update Seminar on 18 September will recall, DEFRA announced its intention to publish such a document “later in the autumn”. At the time of going to press the consultation paper had not appeared, and with autumn rapidly fading into winter this raises inevitable questions concerning the profile of noise within the Department.

However, noise is receiving increasing attention in Government Departments other than DEFRA, from the Home Office to the Number 10 Policy Unit. The impact of noise on “liveability”, the new word for quality of life, is being more widely recognised, both from neighbourhood and ambient noise. The European Court on Human Rights' landmark decision on the plight of those affected by Heathrow will also have significant repercussions, and is unlikely to prove unique.

However, it is domestic noise which dominates complaints and we lead this issue with a report on research carried out at **BRE** into the nature and possible resolution of domestic noise complaints in the UK. The findings mirror many of the conclusions of NSCA's annual Noise Survey, particularly in the area of neighbourhood relations. The research goes much further though, looking at the more detailed aspects of noise disputes and suggesting possible routes to their long term solution.

One of the primary recommendations is an improvement in the level of information collected about complaints, which will need to be in a consistent form. **Professor Stephen Stansfeld** led a group from the University of London looking at just this problem, developing the Standardised Interview to Assess Domestic Noise Complaints and their Effects, or SIANCE. Their report shows how the use of such techniques could help local authorities develop a more structured, consistent and objective approach to noise complaints, and allow better analysis of the problem both locally and nationally.

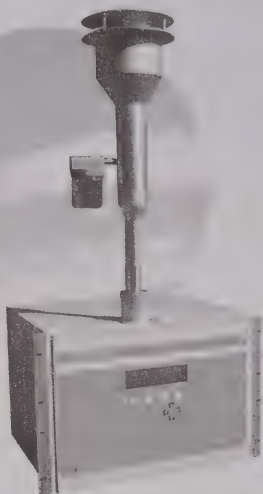
Domestic noise is, though, only one part of the picture, albeit a very important part, and with the EU Noise Directive rapidly approaching completion, ambient noise will become increasingly important. One of the requirements of the Directive will be the production of action plans to reduce ambient noise and our third report, from **WS Atkins**, looks at the synergies between actions aimed at noise and air quality. **Greg Watts**, of TRL Ltd. reports on the results of research aimed at helping to resolve the conflict of noise vs. safety in traffic calming, with the development of low external noise rumble strips.

In our research section, **David Muir** reports on the results of air quality monitoring before and during school holidays, asking the question “how much does the ‘school run’ contribute to poor air quality?”

**Next Issue:** Air Quality

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# Control of Noise Pollution

## Domestic Noise Furthering our Understanding of the Issues Involved in Neighbourhood Noise Disputes

Colin Grimwood and Matthew Ling

Acoustics Centre, BRE

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*Amplified music during the evening and night was found to be the most common noise source involved in this sample of domestic noise complaints. It appears that it may be possible to resolve many of the complaints about amplified music by dealing directly with the noise itself. However secondary noise sources and non-noise issues played an important role in a large proportion of domestic noise complaints and these must also be addressed in order to ensure satisfactory complaint resolution. Possible ways forward include initiatives to encourage direct negotiation between neighbours, to facilitate multi-agency working and to increase the detail in record keeping systems. Improving communication skills, particularly in conflict situations, may prove beneficial in the longer term.*

### 1 Introduction

BRE were asked by the Department of the Environment, Transport and the Regions (DETR) – now DEFRA – to undertake research that would increase understanding of domestic noise complaints.

There are two annual sources of information on national noise complaint statistics – the Chartered Institute of Environmental Health (CIEH) Environmental Health Report and the DETR Digest of Environmental Statistics. Both draw their information from the same annual returns that are completed by local authorities (LAs) in England and Wales and then submitted to the CIEH on a voluntary basis. The most recent CIEH Report states that 148,006 complaints (5,050 per million population) about domestic noise were reported to the CIEH in 1997/98 from 225 responding authorities. In the period between 1986 and 1996 the total number of domestic noise complaints trebled, but this trend has begun to level off during the past few years as illustrated in Figure 1.

For the purposes of this report a 'domestic noise complaint' is considered to be a contact with an LA that has been recorded in an LA record keeping system and that would subsequently be reported as a domestic noise complaint in the annual return to CIEH. The definition is critical to understanding this

research which seeks to investigate the trends and issues involved in reported domestic noise complaints.

There are many aspects of the domestic noise complaint problem that made it a particularly difficult issue to research. There was no readily available complete listing of all domestic noise complaints to serve as a sampling frame. The co-operation of 'volunteer' local authorities was therefore required in order to access the required information. Neither was the information available in any standardised form; some LAs have manual records and some are computerised and all provide varying degrees of detail. Further difficulties arise from the sensitive nature of the subject, from the likelihood of low response, and from the need to obtain prior consent of the LAs and the parties involved before researching some of the complaints in greater detail.

For these reasons a non-probability sampling technique was employed in this study. Thus, this report does not seek to present quantitative information that should be generalised to the population at large, but rather to provide an exploratory look at the patterns in the data. Where quantitative information has been provided this is because it is likely to be of particular interest and indicative of important underlying issues that may help move forward the understanding of this complex problem.

The study was completed in July 1997 and involved the collection of a large amount of qualitative and quantitative information using a variety of social research techniques. The scope of the project was restricted to a general analysis of a sample of 3136 complaints made to a group of 10 LAs from England and Wales during the summer (July – September) of 1995. More detailed views were sought from complainants, investigating officers (IOs) and alleged noise makers (ANMs) involved in a sub-sample of about 250 of these complaints. Five of the LAs offered to take part in the study whilst the remaining five were 'volunteered' so as to achieve a balance in styles of service provision, geographical locations and levels of urbanisation.

This report seeks to provide insights into the issue of domestic noise complaints and to encourage debate that will further our understanding of the problem and assist in the search for solutions.

**Table 1:** Complaint Source Profile

Type of noise	1988 Study Cause of noise complaint (%) (Utley and Buller)	Current Study Main source of noise (%) (n = 3136)	Current Study Secondary source of noise (%) (n = 227)
Music	34 <sup>1</sup>	42	11
Domestic noise	9 <sup>4</sup>	18 <sup>5</sup>	n/a
Dogs barking	33	7	17
Parties	n/a	6	18
House/Car alarms	n/a	3	2
Shouting & banging	n/a	3	n/a
TV or radio	n/a	2	9
DIY	5	2	6
Sound insulation	n/a	1	n/a
Other animals	1	1	2
Car repairs	3	1	1
Banging doors	n/a	1	7
Children playing	n/a	1	5
Domestic appliances	1	1	1
Voices	6	n/a	9
Other <sup>1</sup>	9	n/a	1
Misclassified <sup>2</sup>	n/a	13	n/a

<sup>1</sup> 'Other noises' in the 1988 data includes: fireworks; intimate and personal sounds; bad language; drums; beach buggy racing.

<sup>2</sup> 'Misclassified' complaints are those that were incorrectly recorded as neighbour noise, see Section 6.

<sup>3</sup> 'Music' includes TV or radio in the 1988 data.

<sup>4</sup> 'Domestic activities' in the 1988 data.

<sup>5</sup> See section 6 for discussion of 'domestic noise' category.

## 2 What Were the Complaints About?

The general analysis of the sample of 3136 complaints identified the main sources of noise involved in the complaints (Table 1). Bearing in mind that the sample of complaints was obtained from 10 LAs only, this overall profile may not be representative of national figures. However the various sources and their relative ranking is similar to that found in other studies (e.g. Utley and Buller, 1988; NSCA, 1997).

It is interesting to compare the source profile from this 1997 study with the previous 1988 source profile (columns 2 and 3 in Table 1). Amplified music remains the most common noise source involved in the complaints. There is a suggestion in the data that music complaints are now more preponderant in urban areas than they were in 1988. There is also some indication that complaints about barking dogs may have decreased. However this can only be a tentative suggestion because systems for recording and dealing with dog related complaints vary between LAs; for example some LAs in our sample used animal wardens extensively, recording and processing complaints involving animals separately.

A sub-sample of these 3136 complaints was examined in more detail using self-completion questionnaires. A reasonable agreement was found between the main noise source identified by complainants and the noise source entered in the LA records. However, the majority of complainants also identified that one or more secondary

noise sources were also contributing to the problem (shown in column 4, Table 1). The most commonly mentioned secondary noise sources were noisy parties and barking dogs. It is not clear whether these secondary noise sources were present, or identified by LAs, at the time of the initial complaint but they are an important issue. The presence of such secondary noise sources (perhaps with longstanding history) is indicative of the complex nature of domestic noise complaints and illustrates how dealing only with the main noise source may not resolve a complaint.

An innovative aspect of this research was an attempt to explore the perceptions of all the main participants in a neighbour noise dispute – complainant, alleged noisemaker (ANM) and investigating officer (IO). Reconciling different viewpoints and opinions on the same complaint was methodologically very challenging. However, the study clearly showed some elements of agreement between the groups. The different views of the three main participants on the reasons for the problem are summarised in Table 2. In the majority of cases the noise itself was cited as important. However noise was not always the sole issue, and other (non-noise) factors played an important role. For example, all parties reported that communication difficulties were a contributory factor to the problem. This finding suggests the usefulness of initiatives aimed at improving people's communication skills specifically in the area of conflict resolution.

Table 2: Different Views on the Cause of the Problem

Complainant <sup>1</sup>	Investigating officer	ANM
the noise itself <sup>2</sup> the effects of the noise the cause of the noise <sup>3</sup> communication difficulties lifestyle mismatches sound insulation wider issues e.g. – behaviour of ANM <sup>4</sup> – neglecting pets – victimisation <sup>5</sup>	the noise itself  communication difficulties lifestyle mismatches sound insulation wider issues e.g. – anti-social behaviour	the noise itself  communication difficulties lifestyle mismatches sound insulation wider issues e.g. – behaviour of complainant – investigation procedure – victimisation <sup>5</sup> – a proxy for another problem
<p><sup>1</sup> For complainants the issues, rated in order of importance, were: the noise itself (particularly music complaints), anti-social behaviour by the ANM, sleep disturbance, annoyance and stress, the need to change behaviour, sound insulation.</p> <p><sup>2</sup> For music complaints the acoustic features, rated in order of importance, were: volume, duration, time of occurrence and presence of a repetitive beat.</p> <p><sup>3</sup> Examples include the party rather than the music, the person rather than the noise they made.</p> <p><sup>4</sup> Includes anti-social, abusive and threatening behaviour.</p> <p><sup>5</sup> Either a victim of the noise or a victim of the complaint.</p>		

The multiple factors revealed in Table 2 support the views of other authors on the importance of a multi-agency approach to some neighbour noise conflicts. It appears that it may be possible to deal with many music complaints by dealing directly with the noise itself. This is particularly the case for night-time and for one-off situations. Other complaints, where the noise itself is perhaps not the major factor, may be dealt with more effectively by attempting to deal with the underlying issues rather than the noise. A rigid procedural approach to dealing solely with the noise aspect of a complaint may not resolve the dispute. The current regulatory regime does not encourage consideration of these underlying issues.

3 Who Else have Complainants Contacted for Assistance?

The range of people that complainants had approached to try and resolve the problem (Table 3) was examined. As all of our information originated from LA environmental health department records, it is unsurprising to see environmental health at the top of this table. Table 3 also underlines the finding that many complainants still anticipated police assistance in dealing with aspects of domestic noise disputes. The fact that complainants often used a multi-agency approach to their problem solving may be indicative of a bias towards more serious complaints in our sub-sample. Complainants frequently reported that they had been referred back and forth between the different agencies with no one agency accepting responsibility for all aspects of the complaint. It may well be that at present no one agency (perhaps no agency at all) actually has the responsibility for investigating or resolving aspects of these complaints.

Some complainants complained straight to the authorities. However it is important to note that many complainants had approached the person responsible, and this was usually done before contacting any other agencies. Again this suggests that initiatives to improve communication between neighbours and initiatives to facilitate and promote multi-agency working are likely to be beneficial.

4 When Do Noise Problems Occur?


In the light of recent legislation (i.e. the Noise Act 1996), trends in the times when noise disturbance occurs (Figure 2) were examined. This information was gathered from our complainant sub-sample as it could not be derived from existing LA records. Five main points arising are highlighted in Table 4.

It is clearly important for each individual LA to have comprehensive records of the times when noise problems are actually occurring in its area. Such records can then be used to assist with policy decisions such as the need to provide night-time noise teams and to manage the resources required.

5 Were the Complaints Resolved?

The definition of a ‘resolved’ complaint shows some disparity between the involved parties. A complainant may only consider a complaint resolved when the offending noise or noises cease, or where the other (non-noise) issues have been addressed. A local authority will typically use a more ‘systems’ derived definition (Table 5). The Noise Management Guide (CIEH, 1997) has also suggested a further definition of resolution as shown in Table 6.

**Table 3:** Agencies Contacted by Complainants

Environmental Health		Most frequently contacted
Person responsible		
Police		
Another neighbour		
Local council (other) e.g. Housing, Social Services		
Landlord		
Tenants groups		
Other e.g. Citizens Advice, local councilor, mediation service		

The definition of resolution proposed in the CIEH Guide is deliberately designed to be inclusive (to incorporate the wide variety of policy and procedures developed by LAs) and it will assist simple quantitative comparisons between LAs. However this research highlights that comparisons of rates of resolution between LAs will remain inconclusive, and will certainly not compare quality of service, because following policy and procedure through to completion means different things to different LAs.

In the sample IOs reported that, in their opinion, most cases had been resolved, with the majority of cases not proceeding beyond an initial intervention by the LA. Complainants also reported the majority of complaints to be resolved. However many complaints that had not been pursued by complainants were not actually considered to be resolved. Complainants were asked about this in more detail, and most commonly reported that the noise problem had ceased, but several other reasons were also reported as shown in Table 7. Once again these reasons indicate that improving communication between the parties may offer a way forward. Interestingly, when ANMs were asked whether they considered the complaint to be resolved the most common response was 'don't know'. This is related to a comment made by several ANMs that they were not kept informed about progress or the outcomes of investigations made by the IO. In some cases this was a particularly sensitive issue for ANMs, who were concerned that they did not know the outcome of a complaint against them,

**Table 4:** Times of Disturbance

<ul style="list-style-type: none"> <li>• The number of complainants reporting disturbance broadly increases throughout the day from 06:00 until 23:00.</li> <li>• most disturbance is reported between 22:00 and 02:00.</li> <li>• Lowest levels of disturbance occur between 05:00 and 12:00.</li> <li>• Music was principally responsible for complaints in the period 18:00 to 03:00.</li> <li>• Other noises tend to cause more disturbance in the mornings (07:00 to 10:00) and afternoon (15:00 to 17:00).</li> </ul>
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**Table 5:** Examples of LA Definitions of Resolution Found in Study

- IO considers noise problem solved (may advise complainant informally).
- LA investigation is completed (may advise complainant informally).
- LA investigation is completed (formal follow up e.g. complainants are then informed in writing that the case is to be closed unless further contact is received within a set period – say two weeks).
- Following an initial intervention, cases are closed automatically if complainant makes no further contact during a set period (ranging from two weeks to six months).
- Cases are only considered resolved if they go to court.

especially where they had been asked to modify their behaviour beyond what they considered to be reasonable.

## 6 What Can We Say About Published Complaint Statistics?

Several issues have been identified during this study which result in a need for caution when comparing complaint data between LAs and when interpreting national statistics:

- 'misclassified' complaints
- lack of standardisation in recording of complaints
- vague definitions of 'domestic' and 'neighbour' noise
- incomplete or inadequate information.

Referring back to Table 1 it can be seen that there was a significant proportion of 'misclassified' complaints in our original sample from LA records. These were cases where the complaint did not relate to domestic noise, where the complaint was actually a request for advice or information and cases where the original contact was recorded several times (e.g. with different spelling of names). The inclusion of such entries in LA returns would, of course, inflate the published annual complaint statistics.

In addition, the recording of complaints showed a marked lack of standardisation between LAs (Table 8), which makes interpretation difficult. For example it could be held that the statistics overstate the extent of the problem where a single noise problem is complained about by several people and a separate record is made for each complainant; or where one person repeatedly complains about a single noise issue and a new record is made for each contact with the LA. There was also a lack of cross-referencing within LA record keeping systems between these types of entries.

Referring again to Table 1 the category 'domestic noise' should be commented upon. This term was used differently by different LAs. For example, some LAs used the term generally to encompass all complaints, other LAs used this term where no specific noise source was identified, others where sound insulation problems were reported. Problems

Table 6: CIEH Definition of Resolution

a) No further local authority action is possible and appropriate advice has been given;
or
b) Formal action has been taken;
or
c) That the policy and procedure adopted by the local authority for dealing with noise complaints has been followed through to completion i.e. i) informal action by negotiation or warning letter; or ii) reference has been made to another service outside the local authority's control.

of misclassification and the use of general noise source descriptors in record keeping systems make it difficult to develop appropriate strategies to deal with the issue.

The Noise Management Guide (CIEH, 1997) acknowledges the need and value of more precise complaint categories, but still includes ‘neighbour noise’ as a sub-group of domestic noise sources. The CIEH define this term to include ‘raised voices, banging doors, footfalls etc’ which are more usually associated with sound insulation complaints. The proposed use of a term that would normally also be used in a far wider ‘catch-all’ context, could lead to an over estimation of sound insulation related complaints in the future.

The usefulness of LA records and national statistics would be much improved by the inclusion of greater detail. Better quality information is an important corollary to local and national policy initiatives. For example, this report has emphasised the particular value of accurately identifying both the noise source and the time the noise disturbance occurs.

7 Encouraging Debate on the Best Way Forward

One of the aims of this work is to encourage and inform debate on the best way forward to deal with the problem of

Table 7: Complainants’ Reasons for not Pursuing Complaints


Noise problem ceased		Most common reason
Would worsen problem		
Fear of alleged noise maker		
To avoid bad feelings		
Felt threatened		
Felt intimidated		
Diary sheet too much trouble		
Referred to mediation		
Resolved informally		
Problem insufficiently serious		

Table 8: Recording Systems

• Each contact with the LA about the same problem is recorded as a separate complaint.
• Several contacts by the same person about the same problem are recorded as one complaint.
• Several contacts by different people about the same problem are recorded as several separate complaints.
• Several contacts by different people about the same problem are recorded as one complaint.

neighbour noise. In this study it was apparent that the policies adopted by some LAs to implement their duty to investigate and abate statutory noise nuisance can result in rigid procedures that may not provide the most appropriate approach to dispute resolution. Possible ways forward are presented in Table 9.

8 Acknowledgement

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**Table 9:** The Way Forward?

- a) LA record keeping systems need to be improved. The availability of more detailed information on, for example, the specific type of noise source and actual times of noise disturbance will allow appropriate local policies and procedures to be developed. The standardisation of record keeping systems and mandatory reporting requirements would be useful from a national perspective.
- b) The resolution of domestic noise complaints by direct negotiation between neighbours should be facilitated wherever appropriate. Current legislation and guidance should be reviewed to ensure that this approach is encouraged.
- c) Initiatives to improve communication skills, particularly in conflict situations, may prove to be beneficial in the longer term. Local initiatives aimed at improving communication within neighbourhoods should be encouraged. Possible national initiatives might include involving schools and the use of television advertising.
- d) The particular skills and competencies required by those officers involved in investigating and attempting to resolve domestic noise complaints should be acknowledged and their training needs addressed.
- e) A multi-agency forum could be created for the exchange of experience and good practice. Better multi-agency working, or broader roles for the agency (or agencies) involved, appears essential to achieve dispute resolution.
- f) LAs could usefully review their handling of domestic noise complaints in the context of their power to promote the social, economic and environmental wellbeing of communities as contained in Part I of the Local Government Act 2000. Guidance on the use of this power can currently be found on the DTLR web site at: <http://www.local-regions.dtlr.gov.uk/wellbeing/index.htm>

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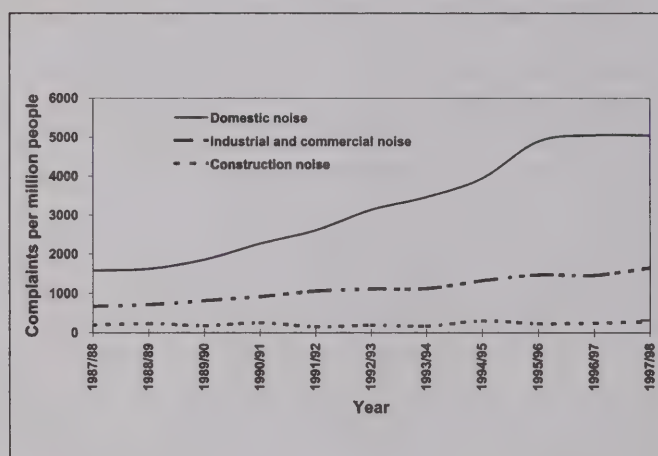
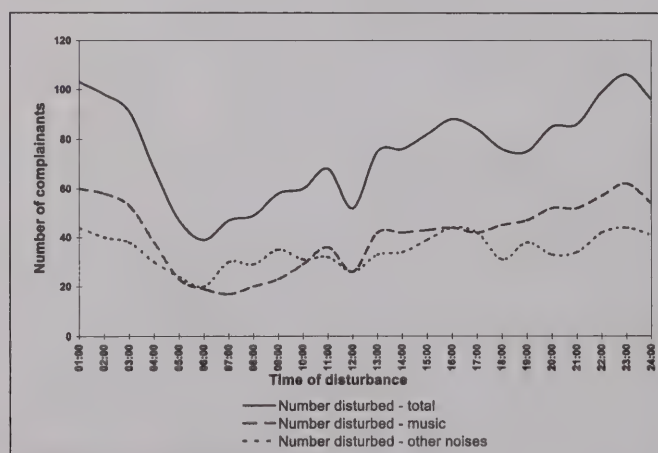
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**Figure 1.** Domestic Noise Complaint Trend (1987-1998)**Figure 2.** Temporal Variation of Disturbance

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# An Introduction to 'The Standardised Interview to Assess Domestic Noise Complaints and their Effects' (SIANCE)

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*Chartered Institute of Environmental Health statistics reveal that domestic noise is now the greatest source of noise nuisance and public complaint. In a survey of 225 responding local authorities, 212,327 noise complaints were received in the year 1997/98, of which 148,006 (70%) were about domestic noise.*

*When a complaint about noise nuisance is made to a local authority it must take such steps as are reasonably practicable to investigate the complaint, gathering evidence to decide whether the noise has caused a common law nuisance, or conditions that are prejudicial to health. Interviews are often used as part of this investigation, but no universally recognised guidance or structured methods are currently available to local authority officers.*

*The development of this interview is beneficial in providing improved guidance on how to assess domestic noise complaints. In addition, with further work to develop a consistent method for using the interview, it will become much easier to collect and analyse national statistics.*

## The Development of the Interview

Initial preparation involved a literature search of previous work carried out in this area. In fact research in the field is limited and there is little evidence on the effects of domestic noise. The evidence which does exist is derived largely from the Chartered Institute of Environmental Health Annual Reports, the BRE National Noise Attitude Surveys and the Noise Surveys conducted by the National Society for Clean Air. A review of the literature on domestic noise and health has been included elsewhere (Stansfeld et al, 2000).

An initial focus group, comprising environmental health officers (EHOs) from approximately 20 London Boroughs, was conducted during a meeting of the Pollution Study Group with a fourfold purpose:

- to gain a better understanding of the current working practices of EHOs dealing with domestic noise complaints;
- to collect expert opinion on the needs of EHOs to inform the interview design;
- to determine whether EHOs would welcome a form of standardised interview; and
- to recruit local authorities who would be willing to pilot the interview.

The research team collaborated with BRE to make appropriate sections of the standardised interview comparable with national data from the 1999/2000 National Noise Attitude Survey (Grimwood, 1999). The draft interview was reviewed by EHOs at a second focus group meeting and a number of changes to the structure and ordering of the interview were made to make the interview more user friendly and reduce the completion time.

## The Design of the Initial Standardised Interview

Due to the time constraints placed upon EHOs investigating domestic noise complaints, we endeavoured to keep the interview brief. The interview is structured in five parts: the main body of the questionnaire, divided into two sections, completion of which is compulsory; and three optional appendices – the first providing a measure of psychological distress, the second relating to further characteristics of the complainant and the third to physical noise measurements.

Wherever possible, existing standard questions are used to measure the various concepts covered by the interview, in order to increase overall reliability and validity. In addition, answers are standardised by providing participants with show-cards illustrating allowable responses.

Below is a description of the scales and questions included in the interview.

### • Section to be Completed with Complainant

The EHO completes this section asking the complainant questions (see Table 1).

### Investigation Details

Details about the attending EHO and his or her local authority are necessary to ensure continuity in the complaint investigation and for audit.

### Complainant Details

Socio-demographic information on each complainant is collected for descriptive and statistical adjustment. Previous studies (Utlei & Keighley, 1989) have shown that demographic variables, such as age, can affect the likelihood of disturbance from neighbourhood noise in general and from some specific noise sources. For example, the age group comprising 25 to 34 year olds is the most likely

to be annoyed or disturbed by peoples' voices, radio/TV/hi-fi, animals and vehicles, with the over 65s being the least bothered by neighbourhood noises.

### **Information about the Noise**

The following information is collected on up to three sources of noise:

- What is the noise?
- Where does the noise come from?
- Do you hear it indoors or outdoors?
- How often does it usually occur?
- How long does it usually last?

The source of the noise is also likely to have an impact on outcome measures such as annoyance, activity disturbance or emotional response and these responses are measured in subsequent sections. People are more annoyed by noises which they feel are avoidable or unimportant, such as doors banging, or which make them feel afraid, such as loud arguments (Grimwood, 1993; Fields, 1993). Details about the source of the noise are obviously necessary for descriptive purposes.

Noise characterisation is essential if we are to begin to understand which types of noise evoke the most complaints. It is possible that the content and character of the noise may be more important than the actual noise level. Consideration has also been given to the time of day that the noise occurs and the duration of each occurrence since these may moderate the effect of the noise. The division of the 24 hour period into day, evening and night is consistent with that used by BRE in the Noise Attitude Survey.

### **Health and Behavioural Effects**

*Annoyance* (Fields, 1992) is the most commonly cited outcome of disturbance by noise. Noise annoyance is measured in this interview using the verbal question format proposed by Fields et al (1998), which gives complainants five response options: not at all annoyed; slightly annoyed; moderately annoyed; very annoyed; and extremely annoyed.

*Activity disturbance* is an important effect of exposure to noise. This is particularly true since the amount of activity disturbance may moderate the level of annoyance experienced. Different noise sources may also be differentially disturbing for different activities. For example, speech activities are more seriously disturbed by aircraft noise than is sleep (Schultz, 1978). The categories of activity disturbance included in the interview are essentially the same as those utilised by BRE in the Noise Attitude Survey with some additional items.

*Emotional response* to noise is a further outcome variable to be included if we are to have an adequate understanding of the subjective nature of the effects of noise. Unwanted noise can elicit a number of emotional reactions, including anger, fear or depression. The overall effect of the noise may depend on which of these emotions the complainant experiences. For example, more

annoyance is experienced when the noise makes the individual feel fearful (e.g. Fields, 1992). The emotional response scale is similar to that used in the BRE National Noise Attitude Survey but with the omission of the positive response options which were felt to be inappropriate in this context since complainants are unlikely to experience favourable emotions when complaining about noise.

### **Characteristics of the Complainant**

*Noise sensitivity* is a concept that is invoked to explain the considerable difference in noise tolerance between individuals at a given level of noise exposure (e.g. Stansfeld, 1992). Noise sensitivity is important because health effects of noise have been found to correlate more closely with reaction than with actual noise exposure. Noise sensitivity is measured by a self report, single question measure of how sensitive the respondent is to noise in general.

### **The Environment**

Various environmental factors that may potentially influence the effects of domestic noise are covered by the interview. These include: various aspects of the type of housing; tenure; the number of years living at the address; the number of people living in the household; general neighbourhood satisfaction; and the number of hours, on average, spent in the home. This information is essential if we are to understand which environmental factors increase vulnerability to noise and the likelihood of a complaint being made. For example, occupants of all types of house, but detached and semi-detached in particular, are less likely to hear noise from neighbours than those living in flats and, are less bothered by the noises they do hear (Langdon & Buller, 1977).

### **Optional Appendix 1 – Health and Wellbeing**

The 12 item General Health Questionnaire (GHQ: Goldberg & Williams, 1988) was chosen because it is a concise, widely used and well-validated measure of psychiatric disorder and psychological distress.

### **Optional Appendix 2 – Further Characteristics of the Complainant**

*Perceived control*, according to Cohen and Spacapan (1984), 'has been implicated as a central determinant of noise on both behaviour and health'. Perceived control is measured using the scale employed in the Whitehall II study (Marmot et al, 1991).

*Coping with the noise*, or rather the strategy employed by an individual in his/her attempts to cope with the noise, has been shown to have an impact on subjective health outcomes (Lercher, 1996). There are three basic coping styles: problem-focused/action-directed, denial/avoidance and palliative/comforting cognitions. According to van Kamp (1990), a problem-focused/action-directed coping style is negatively related and avoidance is positively related to the prevalence of health complaints. Furthermore, an evasive strategy is associated with a significantly higher degree of annoyance. Coping strategy is assessed by asking the complainant to endorse those behaviours in which he or she engages when the noise occurs.

## • Section to be Completed by the Investigating Officer

### General Information

This section includes more detail about the investigating officer and the visit to the complainant's home (see Table 1). Details of previous complaints and their outcomes are also included. If the complainant has previously raised complaints that he or she did not feel were dealt with fairly or efficiently, then this may, in itself, have an impact on outcome measures such as annoyance.

### The Environment

Further aspects of the complainant's housing that are considered important include: the extent of household insulation; the location of the property; and the state of repair of the property.

### Noise Assessment

This section is concerned with the subjective assessment of the noise by the investigating officer and is a means of assessing the severity of the situation in the absence of physical noise measurements. Several aspects of the noise are covered:

- a) the noise source and ambient conditions;
- b) any significant characteristics or features of the noise;
- c) the nature of the noise (i.e. is the noise continuous, cyclic, intermittent); and
- d) any emotional content.

All these features may be salient and are likely to moderate the level of annoyance. The investigating officer is also asked to give his/her opinion as to whether the complaint is justified, whether the noise can be considered a statutory nuisance, and the likely cause of the complaint.

### Optional Appendix 3 – Noise Measurements

In order to assess the validity of the standardised interview, noise exposure was measured in a sub-sample of noise complaint investigations.

Noise from neighbours is typically intermittent and varies over time. Therefore, an adequate sample period is needed to account for these variations. Noise levels were measured using direct measurements carried out on site using tape recordings.

Noise levels of the source should be measured free from the influence of other ambient noise (externally and internally generated). This means that discrete events such as vehicle movements should be excluded from the measurements. Noise levels will then be determined both with and without contribution from the intruding noise, thereby enabling discrimination between the different sources of noise. The aim is to obtain a series of noise measurements, each taken over a 5-minute period, from which the overall noise levels can be derived.

Consultation was made with the Environmental Protection Unit at Hillingdon Borough Council, and BRE, who considered a broad range of guidance in relation to environmental noise. It was decided that the following 5-minute A-weighted noise measurements should be taken:  $L_{eq}$ ;  $L_{10}$ ;  $L_{90}$ ; and  $L_{max}$  (both with and without the intruding noise),

together with a description of the source and ambient noises.  $L_{eq}$  is the most common measure for environmental noise and is closely aligned with the Noise Act 1996.  $L_{10}$  refers to the sound pressure level which is exceeded for 10% of the time, over any given time period, and is, therefore, likely to represent the source noise.  $L_{90}$  refers to noise levels that are exceeded for 90% of the time, within any given time period, and, is used in BS4142 to represent background noise.  $L_{max}$  refers to the maximum sound level, within the recording period. The inclusion of these measurements will enable a number of comparisons to be made against existing guidance and environmental noise criteria.

### Validity and Reliability of SIANCE

For any measure to be useful it must be psychometrically valid and reliable. Detailed statistical analysis of the validity of SIANCE and results from the field study can be found in the Department of Health Report 'The Development of a Standardised Interview to Assess Domestic Noise Complaints and their Effects' available on the Department of Health website ([www.doh.gov.uk/hes/airpol/airpolh.htm](http://www.doh.gov.uk/hes/airpol/airpolh.htm)), hence only a brief summary of reliability will be presented here.

The standardised interview underwent initial field-testing by officers from eight London Boroughs investigating 45 complaints about domestic noise. In order to test whether the interview can be used consistently by different observers, inter-rater reliability was assessed in a sub-sample of 22 noise complaints. Test-retest reliability was assessed by carrying out repeat visits to 13 noise complainants with an interval of approximately 10 days to assess consistency of responses over time.

Inter-rater reliability for the interview as a whole was excellent ( $\alpha = .9989$ ;  $f = 891.07$  (1, 2473);  $p < .00001$ ), as was reliability for each of the individual sections.

Test-retest reliability was acceptable for the interview as a whole, with a correlation coefficient of .771 (d.f.1,1430,  $p < .0001$ ). Those sections that require highly subjective responses from the complainant such as: 'Emotional Response'; 'Noise Sensitivity'; 'Perceived Control' and 'Coping Strategy', were the least reliable over time, reducing overall reliability. In addition, the reliability of questions relating to 'Information about the Noise' was less than desirable. This lack of consistency may be a reflection of the intermittent nature of domestic noise, which makes it difficult for complainants to give precise answers as to when and how often the noise occurs.

### Conclusion

The results of the field study demonstrate that the 'Standardised Interview to Assess Domestic Noise Complaints and their Effects' is psychometrically reliable and valid. Use of the interview will enable local authorities to take a more structured approach towards investigating domestic noise complaints. A means of gathering standardised information from noise complainants is essential if local authorities are to be able to deal with complaints consistently across the country, allowing

meaningful comparison of complaint statistics. Further work with a larger sample is necessary to enable us to begin to establish benchmark scores and criteria for decision making. In the meantime, however, the use of a structured interview may be particularly beneficial in helping both complainants and investigating officers to focus on specific aspects of the noise, thereby eliciting information that may, perhaps, otherwise be forgotten in the emotionally charged situation under which complaint investigations are often conducted. The interview can be used to distinguish between individual cases and assess the severity of the self-reported effects of domestic noise. It is most appropriate for use with long-term chronic complaints, and the structured nature of the information collected may help in making decisions as to whether the noise is prejudicial to health.

We would welcome any local authorities who would like to take part in further field trials of the interview. If you would like to be involved, please contact us at our correspondence address.

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**Table 1:** An Outline of the Parts of the Standardised Interview to Assess Domestic Noise Complaints and their Effects

Sections	Questions and Questionnaires
<b>SECTION TO BE COMPLETED WITH COMPLAINANT</b>	
<i>Complainant Details</i>	Name
	Address
	Sex
	Age
<i>Information about the Noise</i>	Details of the noise source
	Noise characterisation
<i>Health and Behavioural Effects</i>	Noise annoyance
	Activity disturbance
	Emotional response to the noise
<i>Characteristics of Complainant</i>	Noise sensitivity
<i>The Environment</i>	Type of housing
	Sound insulation
	Number of occupants
	General neighbourhood satisfaction
<i>Appendix 1 – Health</i>	Overall Health Status
	12 Item General Health Questionnaire
<i>Appendix 2 – Further characteristics of the complainant</i>	Perceived Control
	Coping with noise
<b>SECTION TO BE COMPLETED BY INVESTIGATING OFFICER</b>	
<i>General Information</i>	Complainant details
	Visit details
	Previous complaints from address
<i>The Environment</i>	Type of housing
<i>Noise Assessment (up to 3 noise sources)</i>	Is noise occurring at time of visit?
	Description of noise source(s) and ambient conditions.
	Description of characteristics and features of the noise.
	Nature of the noise.
	Does the noise convey information content or meaning?
	Is the complaint justifiable?
	Is the noise a statutory nuisance?
	Likely cause of complaint.
<i>Appendix 3 – Noise Measurements</i>	Basic location information
	5 minute period A-weighted noise measurements <i>with intruding noise</i>
	5 minute period A-weighted noise measurements <i>without intruding noise</i>

# Synergies and Conflicts Between Measures to Reduce Traffic Noise and Emissions

Greg Archer, Michele Hackman & Geoff Jackson

WS Atkins Consultants

*This paper examines some of the synergies and conflicts between the objectives of reducing air pollution and noise through local traffic management measures.*

## Introduction

Both local air quality management, and the provisions of the proposed EU Directive on Environmental Noise, require mapping of local air pollution and noise, and development of action plans in identified hotspots. Traffic is a significant source of both air pollution and noise and many of the possible mitigation measures impact upon both issues. This paper investigates some of the potential synergies and conflicts between possible abatement measures to reduce noise and air pollution from traffic. The paper is based upon a study undertaken by WS Atkins Consultants for the DETR (now DEFRA) and devolved administrations. The study report is available on the DEFRA web-site.<sup>1</sup> It examined synergies and conflicts between measures to reduce pollution from a wide range of sources including traffic, industry, airports, railways and quarries and landfill sites.

## Approach

Impacts upon air quality were assessed in terms of changes in emissions or concentrations of  $\text{NO}_x$  and  $\text{PM}_{10}$  using emission rates and assessment approaches drawn from the Design Manual for Roads and Bridges<sup>2</sup> (DMRB) and the CAL3QHCR dispersion model. The calculations were performed for 2005, the first year in which Air Quality Strategy objectives apply for both  $\text{NO}_2$  and  $\text{PM}_{10}$ . Noise calculations were conducted to determine  $L_{eq}$  or  $L_{10}$  (the level exceeded for 10% of the time) using the prediction methods contained in the Department of Transport's memorandum Calculation of Road Traffic Noise (CRTN). CRTN uses a 2-category definition for the traffic composition – cars/light vans and heavy goods vehicles (HGVs). Where a mitigation strategy related to individual classes of vehicle within the HGV category, such as different weights of lorry, the comparative noise source data contained in The Noise Advisory Council publication 'A Guide to Measurement and Prediction of the Equivalent Continuous Sound Level  $L_{eq}$ ,'<sup>4</sup> was used.

The effectiveness, impacts and costs of most mitigation measures are very sensitive to local circumstances and the manner in which the measures are implemented. The results presented in this paper are therefore only illustrative. A robust assessment of the local environmental quality, the principal sources affecting

these areas and all the impacts, costs and benefits of the proposed mitigation measures are an essential prerequisite of any effective action plan.

## Impacts of Changes in Vehicle Flows and in % HGVs of Different Types

For air quality, changes in emissions from vehicles on a road are directly proportional to changes in traffic flows (other parameters being constant). However, the proportionate changes in pollution concentrations will usually be significantly less than those in emissions due to the contribution from other "background" sources. For noise, significant reductions in traffic flows of at least 20% are needed to produce a 1dB(A) change in noise (with constant speed and percentage HGVs). Greater reductions in vehicle flows are therefore required to achieve noticeable differences in noise than for air pollution near roads. Relatively small changes in the proportion and size of HGVs will produce relatively greater effects for noise than changes in vehicle flows.

Vehicle access restrictions can be an effective means of reducing traffic flows and potentially reducing air pollution and noise. Traffic Regulation Orders (TRO) can be implemented for the purpose of improving air quality such as in a Low Emissions Zone. Table 1 shows the impact upon noise and vehicle emissions of restricting access to a range of vehicle types. The assessment assumes that these vehicles are not replaced by other traffic so that some of the estimated reductions will be due to lower traffic flows.

Each of the restrictions produce sizeable reductions in emissions. The results are not significantly different for the two speeds assessed. Noise levels are also reduced as a larger proportion of lorries are removed from the traffic stream. For example, at an average speed of 50 km/hour, removing only the larger lorries would reduce noise levels by 0.9 dB(A), whereas banning all commercial vehicles other than buses and light vans would reduce levels by 2.3 dB(A). The assessment demonstrates that lorry bans have the potential to produce worthwhile improvements in both air quality and noise, especially if used in conjunction with more stringent speed restrictions.

## Bus Use

Changes in vehicle flows can also be achieved by a range of approaches including travel plans and provision of

Table 1: Effect of Vehicle Access Restrictions on Emissions and Noise

	NOx (% change in emissions)		PM10 (% change in emissions)		Noise (change in dB(A))	
	30 km/hr	50 km/hr	30 km/hr	50 km/hr	30 km/hr	50 km/hr
Vehicle Ban						
HGVs <sup>1</sup>	-58	-52	-38	-33	-4.3	-2.3
HGVs <sup>2</sup>	-	-	-	-	-3.7	-1.5
Articulated HGVs <sup>3</sup>	-24	-29	-15	-11	-2.4	-0.9
Pre-Euro I	-19	-25	-18	-19	-	-
Pre-Euro II	-32	-37	-38	-37	-	-
Pre-Euro III	-71	-68	-66	-70	-	-

<sup>1</sup> for noise >1525 kg ulw, for air >3.5 tgw, these are equivalent

<sup>2</sup> for noise > 2 axle >3t ulw ( broadly equivalent to 7.5tgw)

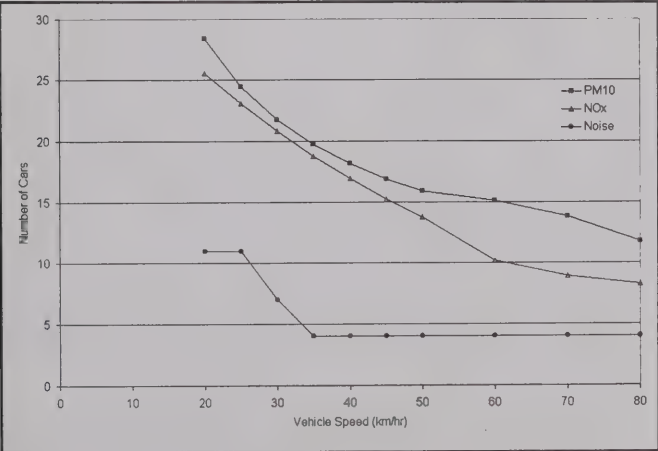
<sup>3</sup> for noise >= 3 axle , for air – no articulated HGVs

Note: An air quality assessment could not be undertaken for HGVs >7.5 t gw as no emission rate information is available for medium goods vehicles (3.5-7.5t gw). A noise assessment could not be undertaken for banning Pre-Euro I, II or III vehicles as no noise data are available.

Assumes a standard vehicle mix of 83% cars, 9% vans, 7% lorries of various types and 1% buses

improved public transport to encourage a modal shift from private vehicles. Many of these methods are designed to use buses to transport former car occupants, but the net impacts of a scheme are highly dependent upon local circumstances as buses tend to emit more air pollution (NO<sub>x</sub> and PM<sub>10</sub>) and be noisier than cars. Figure 1 shows the minimum number of cars that must be removed from the road, for each additional bus, in order to achieve reductions in noise and emissions of NO<sub>x</sub> and PM<sub>10</sub>. The figure assumes that each bus holds 55 passengers and cannot therefore carry more than the equivalent of 27 cars of two people. The calculations used to derive Figure 1 are highly sensitive to the assumptions employed and demonstrate the importance of local assessments to predict likely impacts.

Figure 1. Number of Cars having Emissions and Noise Equivalent to One Bus



Replacing cars with buses could not be beneficial at speeds at or below 20 km/hour, as more than 27 cars would need to be removed in order to achieve a decrease in emissions. If the buses were not filled to capacity, higher speeds would be needed for the scheme to be beneficial. In this example, if the bus was less than 44% full, it cannot be beneficial in terms of emissions at any speed. The limiting parameter at all speeds is PM<sub>10</sub>. If cleaner buses (such as Euro III or Euro IV) were used, a smaller number of cars would need to be removed for the scheme to be beneficial. Use of cleaner buses (or ideally electric) is therefore highly desirable where the intention is to improve local air quality.

For noise, at average vehicular speeds in excess of about 35 km/hour, the noise level/speed relationships are similar for both cars and buses. No further noise advantage is gained at average speeds above this value. The greatest benefits to noise are expected to occur at speeds of 35 km/hr (22 mph) or more, where each additional bus would need to replace only four cars for there to be an equivalent noise output.

Use of Bus Priority Lanes

Figure 1 demonstrates that improvements to air pollution and noise are likely to be greatest at speeds equal to or above 35 km/hour. The use of bus priority lanes can be a highly effective means by which to increase bus speeds and service reliability to promote use. Introducing a bus lane on an existing road is also likely to lead to a reduction in the number of lanes available to other vehicles thereby increasing congestion. The resultant changes in noise and air quality will therefore depend upon relative “other vehicle” and bus speeds and flows before and after the bus lane was introduced. The effects of five scenarios on emissions and noise are shown in Table 2.

**Table 2.** Expected Changes in Emissions and Noise due to Bus Priority Lanes

Scenario Number	Scenario Speeds (km/hr)			Emissions (change as %)		Noise (change in dB(A))
	All before	Bus after	'Other' after	NO <sub>x</sub>	PM <sub>10</sub>	
1	25	50	20	+5	+3	+0.5
2	40	40	25	+19	+17	-2.6
3	40	45	30	+10	+8	-1.6
4	40	50	40	-2	-2	+0.2
5	40	60	25	+14	+15	-1.8

If the bus priority lane does not result in vehicle flow and speed changes, any changes in noise and air quality are expected to be small due to the slightly increased distance between the bulk of the traffic and receptors (assuming that the bus lane is adjacent to the pavement). In the unlikely event that the bus lane was very heavily trafficked (by buses and/or taxis), emissions of PM<sub>10</sub> and NO<sub>x</sub> could potentially increase in the lane closest to the kerb. All of the scenarios where there is a decrease in 'other vehicle' speed are predicted to lead to an increase in emissions that is greater than any decrease in bus emissions. Scenario 4 was predicted to reduce emissions due to the increase in bus speeds and consequent reduction in bus emissions whilst the other vehicle speeds remained constant. The overall change in emissions will be dependent upon the bus proportion in the fleet, with higher bus proportions expected to give a more favourable result.

Sound power levels generally decrease with decreasing vehicular speed. However, below a certain speed (that varies with vehicle type) there is no further decrease. These critical speeds are about: 27-29 km/hour for cars and medium sized lorries; 39 km/hour for buses and 40-47 km/hour for the heavier lorries. Any increase in bus speed above the optimum would lead to increased noise from this source. Table 2 shows that the noise increase due to increases in bus speed will be offset to varying degrees by a reduction in the speed of the other vehicles. The result may vary between a small net noise increase and noise reductions of up to about 3dB(A).

### Changes in Speed

Changes in speed, such as from the introduction of new speed limits, is another area of potential conflict between measures to improve noise and air pollution. The optimum speed for noise varies by fleet composition, but is generally in the range 20-40 km/hr. The optimum speed for NO<sub>x</sub> is about 70 km/hr, whilst for PM<sub>10</sub>, emissions increase below about 90 km/hr. Table 3 shows the expected changes in emissions and noise due to reduced vehicle speed for four scenarios (for a fleet composition with 10% heavy vehicles).

Each of the scenarios is expected to be beneficial to noise whilst only two, (involving a reduction from 70 mph), would be beneficial for air pollution. Speeds in urban areas are often less than 30 mph and some local authorities, generally for

road safety reasons, are considering reducing the speed limit in residential areas from 30 mph to 20 mph. Reducing average vehicle speeds in this manner could reduce noise levels by 0.8 dB(A) but would increase emissions of some pollutants by over a quarter. This would need to be a consideration in any proposed changes to speed limits in urban areas. On motorways and rural dual carriageways, with traffic often travelling in excess of 70 mph, speed restrictions would be beneficial for both noise and air quality.

### Conclusions

Although the majority of traffic management measures designed to reduce either local air pollution or noise do not have a detrimental impact upon the other criteria, in some circumstances conflicts may arise. In particular, measures to reduce average speeds of traffic in urban areas whilst benefiting noise, will increase emissions of air pollution. Also, measures designed to reduce private vehicle use, such as park and ride, travel plans or bus lanes may improve environmental quality in some circumstances; in others, the impacts may be negative, particularly on air quality. Local circumstances will significantly affect the outcomes of any new measures. Scheme-specific assessments are essential in order to optimise the design of the measure, ensure it achieves its intended outcomes and that the costs are justified.

In many urban locations, implementation of a single mitigation measure is unlikely to achieve the desired improvement in environmental quality for air pollution and/or noise. This is partly since a diverse range of sources affect environmental quality; but also since a single measure is unlikely to achieve the required level of improvement. This is particularly true in areas dominated by road traffic sources in which a package of complementary measures within an Action Plan is the preferred approach. Examples of combinations of measures likely to be most effective for road traffic sources are:

- Bus Priority lanes / High Occupancy Vehicle Lanes integrated with a Park and Ride scheme utilising low emission vehicles;
- Construction of a bypass with speed restrictions, quiet road-surface and barriers (if there are properties nearby), together with controls on vehicles entering the bypassed area;

**Table 3.** Expected Changes in Emissions and Noise due to Reduced Speed Limits

Scenario	Emissions (change as %)		Noise (change as dBL <sub>A10</sub> )
	NOx	PM10	
30 mph to 20 mph	+27	+27	-0.8
40 mph to 30 mph	+7	+9	-1.2
70 mph to 60 mph	-8	-4	-1.2
70 mph to 50 mph	-15	-4	-2.5

- Urban traffic control (UTC) systems that can be used to optimise traffic speeds, regulate the volume of traffic entering an area and prioritise flows for public transport lanes.

In some locations, fiscal incentives such as congestion charging or work place parking levies may be required to encourage motorists to use public transport. The benefit of a suite of measures is likely to be greater than the sum of each individual measure.

References

<sup>1</sup> [www.defra.gov.uk/environment/noise/synergy/index.htm](http://www.defra.gov.uk/environment/noise/synergy/index.htm)  
<sup>2</sup> Highways Agency 2000, Department of Transport's Design Manual for Roads and Bridges, Volume 11, Section 3, Annex 5.

<sup>3</sup> Department of Transport/Welsh Office, 1988, Calculation of Road Traffic Noise, HMSO.  
<sup>4</sup> The Noise Advisory Council for Department of the Environment 1978, A Guide to Measurement and Prediction of the Equivalent Continuous Sound Level *L<sub>eq</sub>*, HMSO.

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# Development of an Optimised Traffic Calming Surface

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*Early, mainly empirical studies, on Traffic Calming Surfaces (TCSs) at TRL led to the development of rumble areas and strips that were subsequently employed by local authorities to alert drivers to hazards ahead. The main application foreseen at this early stage was on the high-speed approaches to road hazards in mainly rural areas. For this reason residents' reactions were not given high priority in these early trials although it became clear that there was considerable anecdotal evidence that noise disturbance occurred at some sites. For example, vehicles travelling over a series of rumble strips typically generate a "slap, slap, slap" sound which could have been intrusive in nearby homes.*

More recently the environmental effects of introducing traffic calming surfaces into urban areas has become an issue and the present study was commissioned by the Charging and Local Transport Division for Department for Transport, Local Government and the Regions (DTLR). The requirement was to optimise TCSs so that the driver is alerted without consequential disturbance to residents. This paper reports on an ongoing study where a more fundamental approach was taken to designing appropriate TCSs. This involved a consideration of vehicle resonances and the means of exciting these with a suitable road surface profile without the generation of significant external noise. It was found that for some surfaces, significant horizontal vibrations were generated in the vehicle's suspension which were readily transmitted into the driver's cab. The paper describes the initial results of test track measurements that have led to the identification of potentially suitable designs.

## 1 Design

Approaches considered important in reducing exterior noise caused by TCSs that produce nuisance in the community<sup>1</sup> while maintaining interior levels sufficient to alert drivers were:

- to minimise profile amplitude but maximise the transmission of the tyre vibration into the cab;
- to reduce the tyre excitation to low frequencies to prevent significant audible sound being generated.

It was also important to ensure that as far as possible any new design should conform with UK legislation to avoid the need for local highway authorities to seek special authorisation.

It was considered that raised bars (e.g. rumble strips) or slots and grooves (e.g. imprint surfaces) can produce individual pulses which generate a wide range of

frequencies contributing to noise disturbance. For this reason it was considered important to generate inputs which are as close to a sinusoid shape as possible. This in theory produces a single frequency of oscillation without higher frequency harmonics. There are a number of resonances that could be excited in the vehicle passing over the TCSs. This would produce a relatively large effect for a modest input. The sharpness of the resonant peak will determine the range of speeds for which the resonance will be excited. The approach taken was to excite these frequencies using a sinusoidal road profile. If the distances between profile peaks is  $\lambda$  and the speed of the vehicle is  $v$  m/s then the forcing frequency on the vehicle tyres is given by:

$$f = \frac{v}{\lambda} \text{ Hz}$$

Table 1 lists the wavelengths that were chosen for the initial trial (set 1 surfaces 1A to 1E) together with the frequencies that would be generated at 30mph (48km/h). These wavelengths span nearly two orders of magnitude from those close to body bounce frequencies up to those that would excite tyre cavity resonances. Further surfaces were laid (set 2 surfaces 2A to 2C) to examine the effects of wavelengths that were slightly longer and shorter than the wavelength for 1C that gave the best results. All these surfaces were 20m long and 1m wide. This enabled the nearside wheels of test vehicles to be driven over the surfaces and minimised the test track space needed. Finally full width surfaces were laid (set 3) to examine the effects of amplitude and length of surface and to allow comparisons with existing TCSs, i.e. rumble strips and a herringbone patterned imprinted surface. The lengths of set 3 surfaces are given in Table 1 where these were less than 20m. The rumble strips consisted of seven raised bars 230x13mm spaced at 1.5m centres. The imprinted surface had a pattern of diagonal grooves that were about 7mm deep.

The surfaces were formed from a hot applied polymer modified bitumen based compound. This material is routinely used to produce imprinted patterns on traffic calming features and has been found to possess adequate durability and offers acceptable skid resistance. A mould was used to form the smaller wavelengths and profiled rails and a straight edge for the longer wavelengths. The straight edge was a heated cylinder that spanned the two sets of rails and was slowly dragged across the material to form the sinusoidal profile.

Table 1. Description of TCSs

Profile code	Peak to peak amp./ dimensions (mm)	Wavelength (m)/ description	Forcing frequency at 30mph (Hz)
Set 1(1m wide)			
1A	8.4	0.05	267
1B	7.12	0.13	103
1C	8.24	0.36	37.0
1D	7.40	0.92	14.5
1E	8.40	4.41	3.02
Set 2 (1m wide)			
2A	6.21	0.28	47.6
2B	6.25	0.43	31.0
2C	7.00	0.48	27.8
Set 3 (3m wide)			
3A	6.62	0.35	37
3B	6.40	0.35 (10m long)	37
3C	6.95	0.35 (5m long)	37
3D	4.14	0.35	37
3E	7.0 deep pattern	Herringbone	n/a
3F	15 high and 230 wide at 1500 spacings	Rumble strips (9.5m long)	n/a

2 Measurement Method

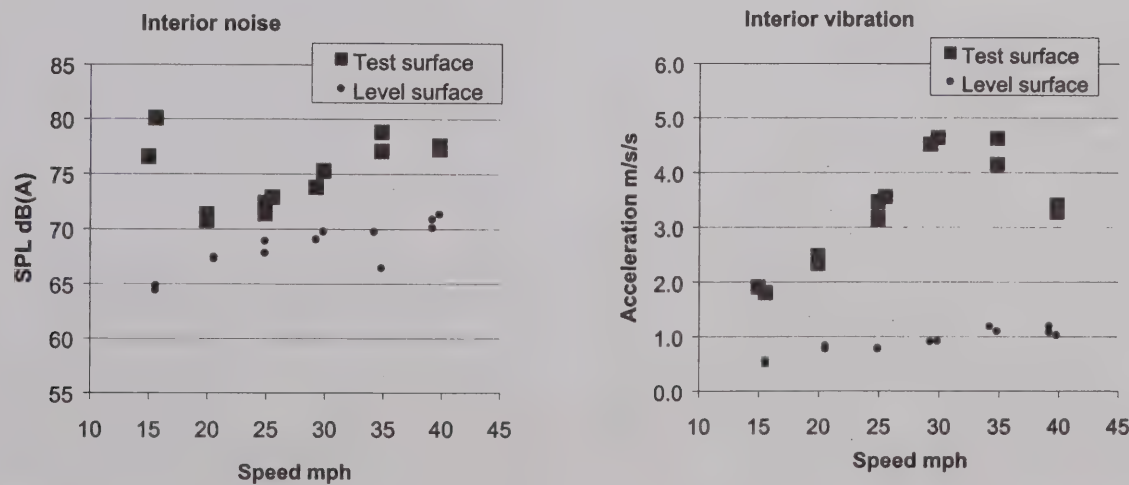
Measurements of maximum exterior noise were taken at 7.5m from the vehicle centre line at a height of 1.2m. For set 3 surfaces additional noise measurements were taken at a distance of 30m. Crossing speeds were measured using a radar speed meter and ranged from 15mph to 40mph (24 to 64km/h) in steps of 5mph (8km/h). Interior noise was monitored near the driver's head position. Vertical vibration was measured using an accelerometer attached to the driver's seat rail. Additional measurements in both vertical and horizontal axes were taken on the front suspension of the smallest vehicle using type 4321 accelerometers. The test vehicles were a small car (Vauxhall Corsa), a mid-sized car (Ford Mondeo), a van (Ford Transit) and a two-axle 17 tonne truck (Renault Dodge). The levels in broad frequency bands (one-third octave levels) and A-weighted levels were averaged over contiguous 400 or 500ms intervals as the test vehicle

crossed each surface. For analysis purposes the maximum A-weighted noise levels and the maximum linear vibration levels were used.

3 Results and Conclusions

The results from set 1 and 2 surfaces clearly indicated the advantage of surface 1C with a wavelength of 0.35m. Generally this surface produced the highest levels of interior noise and vibration without generating significant increases in exterior noise. Generally surfaces with smaller wavelengths <0.35m produced appreciable increases in exterior noise. Those with longer wavelengths did not produce a significant increase in exterior noise but they were ineffective in producing sufficient increases in interior noise and vibration to alert drivers. The specification of 1C was therefore used in the design of the final set 3 surfaces.

Figure 1. Interior Noise and Vibration for Ford Mondeo over Surface 3A



**Figure 2.** Exterior Noise at 30m produced by Ford Mondeo over Set 3 Surfaces

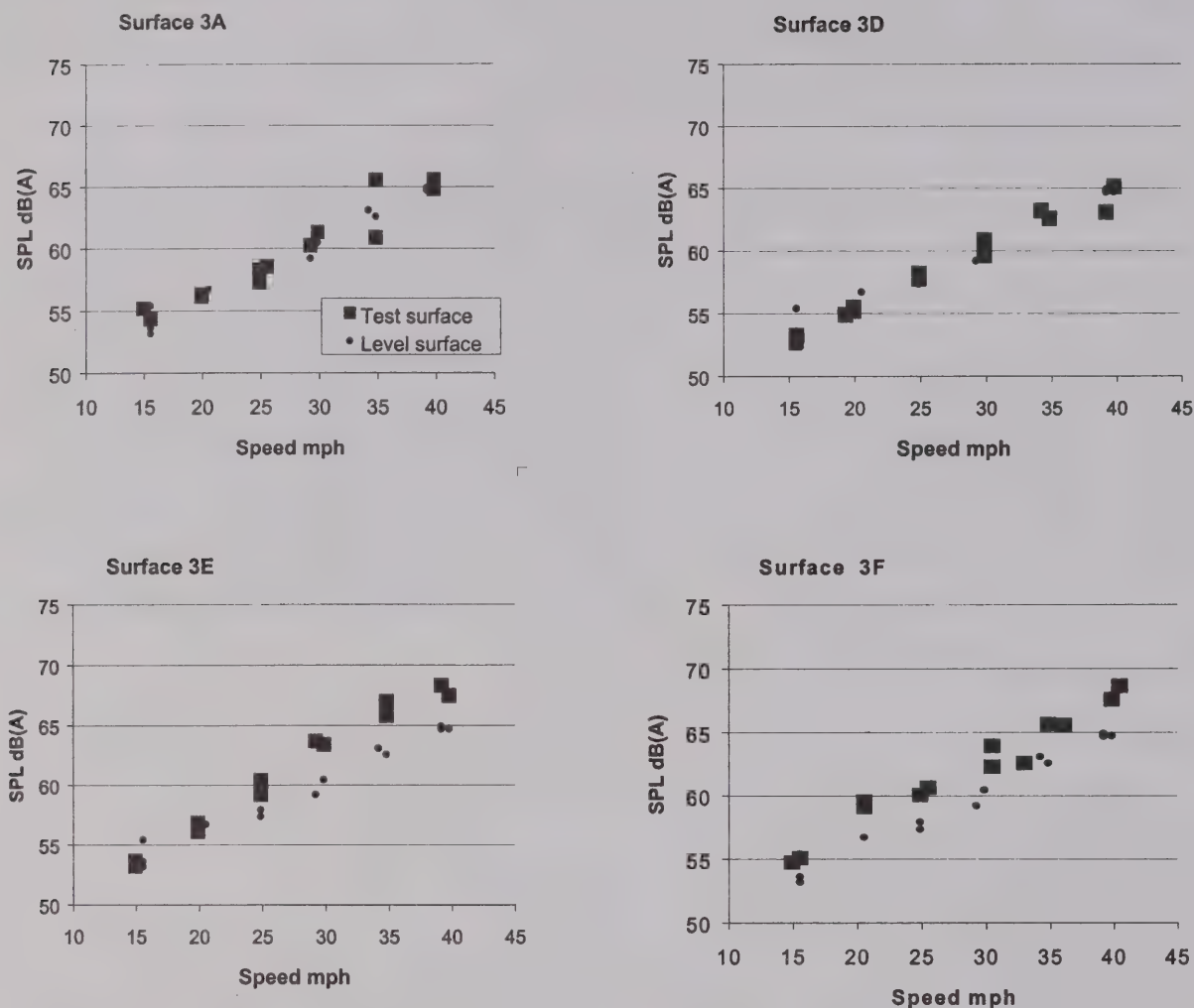


Figure 1 shows the significant increase in interior noise and vibration for the Ford Mondeo car travelling over surface 3A. The results for the level track surface are given for comparison.

For the same vehicle Figure 2 shows the results of the measurements of exterior noise at a distance of 30m for the full length set 3 surfaces. It can be seen that there were no significant increases in external noise measured on the sinusoidal profiles 3A and 3D, while there were significant increases in the noise alongside the herringbone pattern (E) and rumble strips (F) especially at the higher speeds. Similar results were obtained for the smallest car and van. The truck produced small increases of a few dB(A) at the lowest speeds over 3A but there was no consistent increase on surface 3D or 3E. On surface 3F there were significant increases of up to 5dB(A). Generally similar results were obtained at the closer distance of 7.5m.

Road trials are currently being carried out using the most successful design (3A) where changes in vehicle speeds and external noise are being measured and the views of local residents sampled. Some important features that were included in the final design were the provision of ramps on the leading edges of the surface in order to reduce vehicle body rattles and the use of unprofiled material near the road edge for use by cyclists.

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*G.R. Watts, R. Stait, N.S. Godfrey and R.E. Layfield,  
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# Research

## A Study of the Differences Between Pollution Levels During School Term Time and School Holidays

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### Introduction

*As those local authorities which have declared, or are about to declare, Air Quality Management Areas (AQMAs) move into developing their Action Plans they will have to develop measures which are both feasible and which offer the possibility of genuine improvements in air quality. Such measures will also be more attractive if they can be implemented with a minimum of financial investment. This paper does not seek to provide a definitive answer to the question of what measures might be introduced, rather it examines an issue which may provide some indications of how air quality may be improved and, possibly, how much improvement might be achieved.*

There has long been a feeling that traffic patterns during school holidays are different to those during school term times and there is a clear, albeit subjective, perception that there is less congestion during the holiday periods. There are a number of possible reasons for this. These include combining the “school run” with going to work and generally reduced traffic outside term times because of family holidays. The latter may not always be the case where a town or city is a tourist attraction.

It may then be possible to look at levels of air pollution related to road traffic during the two different periods to see if there are any real differences between the two; if it transpires that there are, then it may be possible, given reliable traffic flow data, to relate those differences to the differences, if any, in traffic flows and to develop a model to determine the extent of traffic reduction which may be needed to meet the Air Quality Objectives in a particular town or city.

### Methodology

Initially data from the National Air Quality Information Archive have been analysed for the Bristol Centre, Bristol Old Market (both monitoring inorganic pollutants) and the former Bristol East (monitoring hydrocarbons) automatic national network sites. The data were manipulated in a number of ways to show the diurnal variations in concentrations of the various pollutants for all days for

which data are available, for school term times and for school holidays. The data were further sub-divided to examine weekdays and weekend days for all periods of the year, for summer and for winter. For this purpose summer was defined as being 1 April to 30 September and winter as 1 October to 31 March.

The data showed that there were some differences between term times and holidays although as initially presented these did not appear to be very large. Further analysis was then carried out to calculate the percentage difference in these values from the overall average diurnal concentrations. This proved to be far more effective in revealing the information which could be obtained from these data.

Continuous traffic count data were obtained for one location in Central Bristol. This is a very busy road, certainly much busier than the roads closest to the Bristol Centre site, and data were only available from September 1997. There were also some substantial gaps in the data. Even so it was felt that these data might provide some indication of the differences, if any, in traffic flows between the two periods.

Further analysis was then carried out on the same type of pollution data from the Birmingham East and London North Kensington sites, both of which are located in the grounds of schools, as was the Bristol East site. This presents a possible opportunity of assessing the direct effects, if any, of the “school run”. Secondly they provide an opportunity to demonstrate whether or not the Bristol observations were representative, or at least broadly representative, of urban areas.

A suggestion was made that in Central London there did not appear to be any particularly noticeable differences in pollution levels between school term times and holiday times; data from London Marylebone Road, London Camden Roadside, London Bloomsbury and London Eltham were also examined as representing a range of site types within London. For these the Kensington & Chelsea academic year dates were used as a, presumed, reasonable approximation. This was because this part of the study was only intended to provide indicative information. In the case of the Marylebone Road site data for nitrogen dioxide, PM<sub>10</sub> and benzene were analysed but for the other sites only nitrogen dioxide was considered.

Finally data for nitrogen dioxide from the site at Narberth in Pembrokeshire were examined to see if there were any noticeable differences at a rural site. Annual average concentrations of nitrogen dioxide here are, naturally, much lower than at urban sites, typically 3–4 ppb compared with, typically, 20 ppb. It is likely that much of the nitrogen dioxide measured here derives from urban areas but dispersed and diluted so that relatively little of the typical diurnal patterns found in urban areas remains.

The pollutants studied were nitrogen dioxide, PM<sub>10</sub> and benzene and all data used were fully ratified by NETCEN. The first two were selected because they are the pollutants which have been responsible for the majority of declared AQMAs and the latter because the main source is road traffic.

## Observations

The initial analysis of the Bristol data showed a general marked reduction in concentrations of all pollutants considered relative to the long term averages at all the sites during the school holidays and a small increase during the term times when all weekdays were considered. This refers specifically to the hours between 0700 and 1700. There were marked differences between the summer and winter periods at the Bristol Centre site for nitrogen dioxide, with some small increases recorded in the summer period. At the Bristol Old Market site, however, there were decreases in both seasons, albeit larger during the winter school holidays. There were decreases in PM<sub>10</sub> and benzene in both the summer and winter periods although these were greater in winter than in summer.

When the Birmingham data was examined a broadly similar pattern was found although the percentage differences were, perhaps not surprisingly, somewhat different to those observed in Bristol. The one difference was that there were reductions in nitrogen dioxide concentrations in both summer and winter in contrast to the small increases at Bristol Centre during the summer.

The North Kensington data showed general similarities to the Bristol Centre data, including some small increases in nitrogen dioxide during the summer months, and in concentrations of PM<sub>10</sub>, as well as some decreases.

Marylebone Road provides something of a contrast with nitrogen dioxide as there is less ( $\pm 5\%$ ) variation from the long term average concentrations than at the sites considered so far. Also, the pattern of variation is more or less random. There are far more clear and consistent reductions in concentrations of PM<sub>10</sub> and benzene in the school holidays.

At the other London sites and at Narberth only nitrogen dioxide was examined. At London Bloomsbury there was a far more regular pattern than at Marylebone Road but the variations were again small. At the other sites there were larger differences but whilst there were consistent decreases in both summer and winter at the Camden Roadside site at the Background/Suburban Eltham site there were again some small increases during the summer. At Narberth there

were large percentage reductions in concentrations of nitrogen dioxide in the assumed school holidays. These, however are the consequence of small changes in low concentrations.

Figures 1 and 2 illustrate typical differences.

All the above observations relate to weekdays. The picture for weekends is rather confused, with both increases and decreases in concentrations of all the pollutants considered.

## Discussion

This study demonstrates that there does appear to be significant differences between pollution levels measured during school holidays and term time, at least on weekdays. There are, however, a number of issues which must be considered before attempting to draw conclusions. Of the pollutants considered only one, benzene, is predominantly directly emitted from vehicle exhausts. Some nitrogen dioxide is emitted directly from vehicle exhausts but it is mainly formed in the atmosphere by the oxidation of nitric oxide which is a major direct emission. Nonetheless it was decided to examine nitrogen dioxide as it is a major reason for AQMA declaration. The situation with PM<sub>10</sub> is more complex as measured urban PM<sub>10</sub> has a variety of sources of which vehicle exhaust is only one. It was however considered important to study PM<sub>10</sub> because in the long term it may well prove to be the most important urban pollutant from a health perspective.

Although limited the traffic data demonstrated that the perceived differences between school term time and holidays do appear to be real. Because these data derive from a site on a very busy stretch of road it seems more realistic to relate them to the Bristol Old Market roadside site data than to the Bristol Centre background site data. In order to compare like with like as far as reasonably possible data prior to September 1997 were omitted from the Old Market dataset. It would be unrealistic to expect exact matches between the two datasets in part because of the different locations but probably more because of the partial/primary/secondary nature of nitrogen dioxide. Nevertheless there are indications that traffic and pollution levels are linked to at least some extent. It is quite likely that there would be a closer relationship between the traffic flows and a directly emitted pollutant.

The question does arise of whether it is essential to use traffic count data obtained in the close vicinity of a monitoring station or whether more general data will be adequate for the purposes of calculating reductions of traffic needed to meet the Air Quality Objectives. Although there is a strong case for adopting the first approach when investigating short term pollution episodes there would appear to be little difficulty in using the second approach for the type of work described here especially if data from a number of representative locations are averaged. This is because the pollution data represent averages over relatively long periods and the traffic data should reflect overall reductions with a reasonable degree of accuracy.

Another question which should be considered is whether the “school run” has direct impacts on traffic volumes, congestion and air pollution levels or whether school holidays are the key factor because urban traffic levels are lower as a consequence of people leaving these areas when families can travel together. A parallel consideration is whether people travel to work at different times during the school holidays because they are not constrained by taking children to and from schools at fixed times.

Any answers to these questions can only be speculative but the evidence presented here seems to suggest that the holiday factor and consequential effects may be the key issues rather than any direct impacts of the “school run”. The reductions in pollution levels at the school sites do not seem to be especially greater at the time of the “school run” than at other times. Also there are reductions at the weekends during the school holidays which are not evident during term times. The effects of the “school run” would seem to be more a consequence of higher levels of traffic and congestion which occur at the beginning and end of the school day. The absence of any obvious direct effects should not be taken as suggesting that alternatives to the “school run” should not be found. Apart from the knock on effects on traffic volume and congestion there are other benefits which would accrue from alternatives such as walking, cycling, or using some form of public transport or school buses.

The data from the Marylebone Road site may provide a further pointer to the “holiday effect”. During the school holidays concentrations of nitrogen dioxide are generally higher than the long term average although there are small reductions for PM<sub>10</sub> and larger ones for benzene. This is the only case in those examined where there was an increase in concentrations during the school holidays during the daytime hours. However Central London is likely to be an area which attracts tourists and it may be that this increase is a consequence of this although this does not explain the reductions in PM<sub>10</sub> and benzene concentrations.

The small differences noted at weekends can probably be explained by the fact that traffic levels are generally lower at weekends and that the diurnal pattern of variation is different from weekdays. There is no immediate explanation of the small increases in concentrations of nitrogen dioxide at Bristol Centre during the summer. It is, however, possible that the greater availability of ozone to oxidise nitric oxide during the summer school holidays may be a factor in this.

There have been suggestions that the academic year be changed from the present three term system to, possibly, five terms of similar duration. It is unclear whether this would influence the differences reported here or whether it would have little or no effect. It is impossible to be certain which of these would be the case although it would seem reasonable to believe that the second case is the more likely. This also suggests a possible area of uncertainty in this study as there are schools and colleges which do not follow the local authority academic year. Public schools where Saturday classes are held and terms are shorter are one example, the Technology Colleges where terms are totally different are another. Although these may have a small effect it is not believed that they invalidate any of the observations made.

## Conclusions

1. There are generally clear differences between concentrations of traffic related air pollutants measured during school term time and school holidays.
2. There are many general similarities between the patterns of differences in different cities and at different site types but there are also a number of individual characteristics at different sites. There is also one instance (Marylebone Road) of a reversal of trends observed elsewhere.
3. Although it was only possible to carry out a limited comparison between the reductions in measured pollution concentrations with traffic flows the two do appear to be linked. From this it appears reasonable to assume that this could be used to give at least an indication of the amount of traffic reduction necessary to achieve a given reduction in pollution concentrations. This is an area where more data and more work are required.
4. There is no firm evidence to suggest that the “school run” makes a significant direct contribution to measured pollution levels, rather it is the more general influence which it has on congestion and overall traffic volumes which are important. Equally the opportunity the school holidays present for families to leave urban areas appears to be important.
5. It may be important to consider the potential effects on air quality of the proposed changes to the academic year.

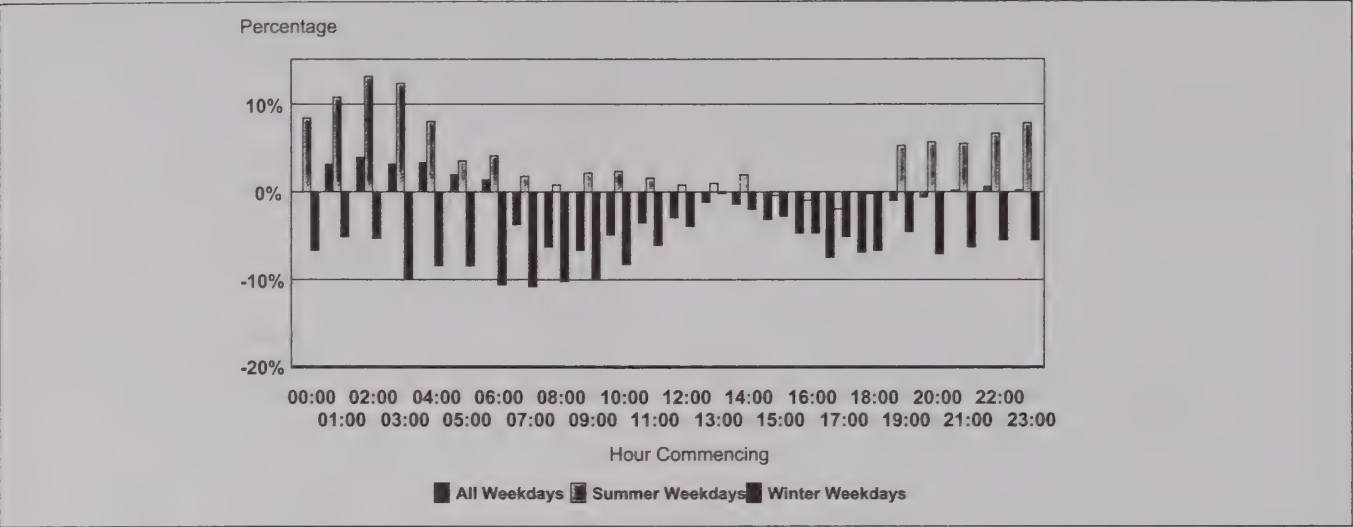
## Acknowledgements

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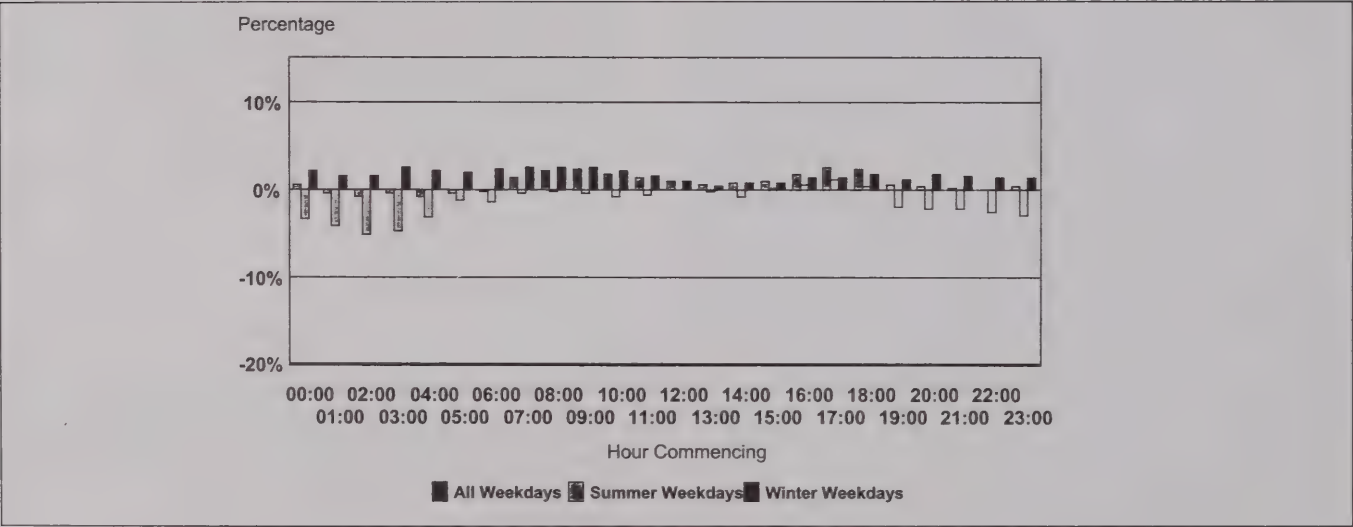
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**Figure 1.** Bristol Centre NO<sub>2</sub> as Percentage of Diurnal Average: School Holidays



**Figure 2.** Bristol Centre NO<sub>2</sub> as Percentage of Diurnal Average: Term Time



# 2002

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